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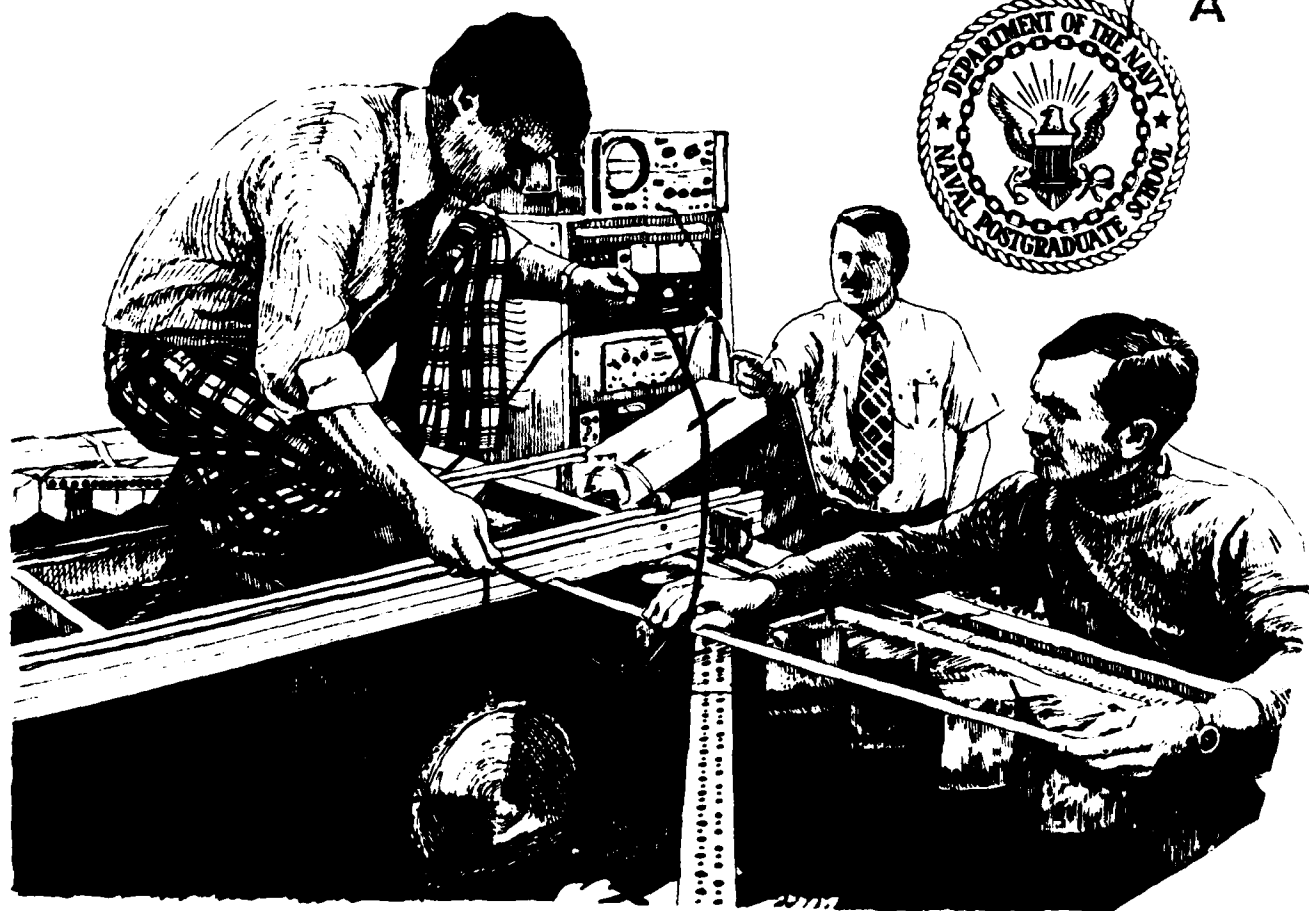# A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM

REPORT FOR THE PERIOD
1 OCT 1981 TO 30 SEPT 1982

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**NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA**

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Rear Admiral John J. Ekelund   David A. Schrady
Superintendent   Provost

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Naval Postgraduate School
Research Program
Summary Report

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report contains 249 summaries on research projects which were carried out under funding to the Naval Postgraduate School Research Program. This research was carried out in the areas of Computer Science, Mathematics, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical Engineering, Meterology, Aeronautics, Oceanography and Mechanical Engineering. The Table of Contents identifies the areas of research.

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A SUMMARY OF RESEARCH ACTIVITIES

INTRODUCTION AND BACKGROUND

Research activities performed at the Naval Postgraduate School
(NPS) during fiscal year 1982 are abstracted in this summary volume.
These results are due to the efforts of principal investigators
(faculty members at NPS) with, in most cases, student contributions
through activity leading to a thesis in pursuit of an advanced degree.

The importance of research at NPS is recognized in the mission
Statement:

> "...to encourage a program of research in
> order to sustain academic excellence."

Research performed at an educational institution such as NPS
provides not only the benefits of original investigations inherent
in all research activities but, in addition, contributes to the
knowledge base and vitality of the educational activities at the
institution. Sponsor benefits include augmentation of research
efforts with student activity, and exposure of students to areas of
current concern.

The Naval Postgraduate School provides a unique interface between
academic institutions and the Navy. As such, the research projects
undertaken are, in general, clearly related to Navy and DOD interests.
A substantially larger fraction of the R&D effort at NPS is in the
exploratory development category than would be found in most universities.
This is a result of student interests as well as faculty motivation
created by the environment at NPS.

Support of NPS research activities has diversified to presently
include more than seventy separate sponsoring agencies. The enclosed
summaries indicate the level of activity and the diversity of efforts
in support of both education and R&D.

NAVAL POSTGRADUATE SCHOOL
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Superintendent   Provost

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the Naval Postgraduate School should be addressed to:

Superintendent
Naval Postgraduate School
(Attn: Research Administration, Code 0121)
Monterey, California 93940

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DEPARTMENT

OF

COMPUTER SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

The research programs of the Computer Science Department consist of student thesis work and faculty research in the core areas of computer science and in the application of computer science to Navy problems. The Departmental research efforts have allowed the development of extensive research facilities that feature microcomputers, minicomputers, computer graphic devices, and image and signal processing equipment.

ADA EXTENSION AND EVALUATION

C. Arnold studies the extension of the ADA language for signal processing. He is also trying to establish a B-test site for ADA in the Department.

AUTOMATIC DESIGN OF ALGORITHMS

D. R. Smith has continued his research on the automatic design of computer algorithms from user-supplied formal specifications. The work has included a formalism for representing problems, abstract control structures and correctness schemes, and the developmemt of a new class of deductive mechanisms.

BENCHMARKING OF A DATABASE MACHINE

D. K. Hsiao, P. Strawser and four thesis students are exploring the use of a benchmarking methodology to evaluate a database machine known as IDM500. The aim is to develop the benchmarking methodology for evaluating the performance of database machines at large.

COMPUTER-AIDED DESIGN

A. A. Ross is investigating the application of very high-level languages, syntax directed editors, programmer's workstations, scheduling theory, and hardware descriptive languages to the design of digital processor based systems. The research is combining the ideas of language translators and graphical hardware design aids to produce a Design Environment which will assist the engineer or system designer in the development of a problem solution which includes digital hardware, software, test plans and documentation.

COMPUTER PERFORMANCE EVALUATION

A. A. Ross is developing a research plan to address the CPE techniques and modeling tools which are applicable to the class of "super-mini" computers which are being widely used in the Department of Defense. Existing CPE tools and techniques are generally used on large mainframe computers which are used for general purpose scientific computing or data processing. The "super-mini" computers like the VAX, Prime, and Data General Eclipse are usually more resource limited and are used for

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dedicated special purpose programs. Tools do not exist for modelling their hardware, operating systems, or workloads.

DISTRIBUTED DATABASES

D. Z. Badal has continued his work on concurrency control mechanisms for distributed database systems. The research has focused on the study of concurrency overhead and mechanisms.

LARGE-SCALE OPTIMIZATION

G. Bradley and G. Brown have continued their research on the solution of large scale optimization problems. The research has extended network optimization to include models with elastic and mixed integer features, constructed a microcomputer-based system for optimization problems, and developed interactive model-building systems.

MAN-MACHINE INTERFACE

G. A. Rahe has done research on the development of embedded tutorials to reduce equipment training costs. The research has focused on the development of a self-paced computer aided instructional learning tool for the Ramtek 9400 color Graphics Display System.

MULTI-BACKEND DATABASE SYSTEM

This research project is being conducted by a number of faculty members and students. They are investigating the use of multiple minicomputers in a parallel fashion to anticipate the database growth and performance gain. The emphasis is on a novel software architecture utilizing replicatable system modules. D. K. Hsiao is the principal investigator.

MULTI-MICROMPUTER ARCHITECTURE

U. R. Kodres, M. L. Cotton and R. Panholzer have continued their study of the use of very large scale integration technology in the SPY-1A radar control. The research involves hardware interface development using fiberoptics, implementation of skeletal weapons control systems interface and command and decision interface, and system's programming and performance analysis.

OPERATING SYSTEMS FOR COMBAT SYSTEMS

U. R. Kodres and R. R. Schell have investigated hardware and operating systems software characteristics for effective use of multi-microcomputers in combat systems. The research has focused on operating systems structures that will support combat system applications, architectural guidelines for hardware design, and hardware and operating system features to enhance implementation of secure systems.

SOFTWARE DEVELOPMENT

B. J. MacLennan has continued the development of the theory and practical methodology for advanced software development. The research has involved the development and comparison of formal models of systems, the development of a method of determining the major structural components of programming languages, a demonstration of the use of relational calculus operators in very high level languages, and an investigation of tools to enhance the development and maintenance of software.

Title:	Design, Analysis and Implementation of Multi-backend Database System
Investigators:	David K. Hsiao, Professor and Chairman of Computer Science (Principal Investigator) and Paula Strawser, Instructor of Computer Science
Sponsor:	Office of Naval Research and the Digital Equipment Corporation
Objective:	To explore the use of multiple minicomputers in a parallel fashion to anticipate the database growth and performance gain.
Summary:	This work is conducted in the Lab for Database Systems Research at the Ohio State University. The staff consists of two faculty members, three graduate students, and professional staff. The objective is to complete the implementation of an experimental system by June of 1983 and move the hardware and the software from Ohio State to the Naval Postgraduate School. Professor Douglas Kerr, the present Director of the lab, will be spending a year sabbatical at the Naval Postgraduate School and will continue the research work here. Two of the students on the research project may also join the Naval Postgraduate School as Visiting Scholars since they will be finishing their course work there towards Ph.D. candidacy.
Publications:	David K. Hsiao, et. al, "The Implementation of a Multi-backend Database System (MDBS): Part I - An Exercise in Database Software Engineering", Proceedings of the International Workshop on Database Machines, San Diego, August 1982.
	X. G. He, et. al, "The Implementation of a Multi-backend Database System (MDBS): Part II - The Design of a Prototype MDBS:, Proceedings of the International Workshop on Database Machines, San Diego, August 1982.
	M. J. Menon and D. K. Hsiao, "Design and Analysis of Join Operations of Database Machines", Proceedings of the International Workshop on Database Machines, San Diego, August 1982.

GORDON H. BRADLEY, PROFESSOR OF COMPUTER SCIENCE IS CO-INVESTIGATOR WITH GERALD G. BROWN, PROFESSOR OF OPERATIONS RESEARCH ON THE LARGE SCALE OPTIMIZATION PROJECT (SEE PAGE 101).

Title:	Distributed vs. Centralized Database Systems
Investigator:	Dushan Z. Badal, Associate Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	The purpose of this investigation was to analyze the impact of concurrency control on transaction execution cost and system performance in centralized and distributed data base management systems based on long haul and local area networks.
Summary:	The purpose of this research is twofold. First, we investigate the impact of concurrency control on transaction execution cost and system throughput in centralized and distributed data base systems (DBS) based on slow and fast (local) networks. Second, we show that in terms of transaction execution cost and DBS throughput there are some applications for which any distributed DBS can be more effective than any centralized DBS and vice versa. We also argue that for other applications the decision in favor of distributed or centralized DBS should be based on the comparison of specific DBS systems.
Publications:	D. Z. Badal, "The Effects of Concurrency Control on Centralized DBMS and Distributed DBMS Based on Long Haul and Local Networks," Proceedings of 2nd International Symposium on Distributed Databases, Berlin, Sept. 1-3, 1982. D. Z. Badal, "Distributed vs. Centralized Database Systems - Transaction Execution Cost and Performance Analysis," NPS Technical Report, NPS52-82-007, July 1982.

Title: Benchmarking of a Database Machine

Investigators: David K. Hsiao, Professor and Chairman of
                         the Computer Science Department, and
                         Paula Strawser, Instructor in Computer Science

Sponsor: Pacific Missile Test Center

Objective: To explore the use of benchmarking methodology
                         to evaluate the database machine known as
                         IDM500.

Summary: This project consists of two main efforts.
                         The first is to develop a general methodology
                         for benchmarking database machines. The second
                         is the application of the methodology to a
                         particular database machine known as IDM500.
                         There are four students involved in the project
                         towards various theses work.

Publication: David K. Hsiao, "Cost-Effective Ways of Improving
                         Database Computer Performance", Proceedings of
                         AFIPS - National Computer Conference,1983.

Conference
Presentation: David K. Hsiao, "Cost-Effective Ways of Improving
                         Database Computer Performance," AFIPS - National
                         Computer Conference, Anaheim, CA, 1983

Title: Emulation of a Multi-Microcomputer Architecture for the SPY-1A Radar Control Computer

Investigators: Uno R. Kodres, Associate Professor of Computer Science, Mitchell L. Cotton, Associate Professor of Electrical Engineering and Rudolf Panholzer, Professor of Electrical Engineering

Sponsor: Naval Sea Systems Command

Objective: To explore the use of VLSI (Very Large Scale Integration) technology in the application of SPY-1A radar control.

Summary: This continuing project is subdivided into: hardware development, applications software development, system's programming, and performance analysis. The design and implementation of the fiberoptic ring interface has been completed. A parallel interface between the multicomputer system's model and a model of the Command and Decision subsystem has been completed. The adaption of the magnetic bubble memory system allows the simulation of intermediate speed input/output interfaces to the system's model. The adaption of high speed disk interface allows for simulating and emulating high speed input/output interfaces to the system's model. A foundation for the construction of a single thread model was generated and three quarters of the modules necessary for the single thread emulation have been constructed. The Multi-Computer Real-Time Executive (MCORTEX) has become easier to use and several new features have been added. The initial evaluation of the new Intel 432 processor was completed. An analysis of performance of multiple computer systems was completed.

Publication: U. R. Kodres, "Processing Efficiency of a Class of Multicomputer Systems," MIMI '82, Proceedings of the Society of Mini and Microcomputers, Cambridge, MA, July 1982, (accepted for publication).

Conference
Presentation: U. R. Kodres, "Processing Efficiency of a Class of Multicomputer Systems," MIMI 82, Cambridge, MA, July 1982.

Theses Directed: R. K. Burns, "A Local Area Fiber-Optic Network for Multiple Microcomputers," Engineer's Thesis, December 1981.

M. S. Hicklin and J. A. Neufeld, "Adaption of Magnetic Bubble Memory in a Standard Microcomputer Environment," Master's Thesis, December 1981.

W. H. Brown, "Design of a Hard Disk Controller for the SPY-1A Model," Master's Thesis, December 1981.

E. R. Cox, "A Real-Time Distributed Operating System for a Multiple Computer System," Master's Thesis, December 1981.

R. S. Riche and C. E. Williams, "A Software Foundation for AN/SPY-1A Radar Control," Master's Thesis, December 1981.

R. M. Grant III, "A Multi-Microprocessor Based Model of the AEGIS AN/SPY-1A Radar Control: Radar Scheduler Process," Master's Thesis, June 1982.

S. G. Klinefelter, "Implementation of a Real-Time Distributed Operating System for a Multiple Computer System," Master's Thesis, June 1982.

R. T. Holdcroft and D. R. Shoop II, "A Comparative Analysis of INTEL's 432 General Data Processor and Control Data's AN/AYK-14(V) Computer System," Master's Thesis, June 1982.

J. V. Cech, "A Multi-Mircroprocessor Based Model of the AEGIS AN/SPY-1A Radar Control: Track Processing," Master's Thesis, October 1982.

R. J. Goldsworthy and T. H. McNair, "Hardware Realization of a Fiber Optic Ring Network," Master's Thesis, October 1982.

J. W. John, "Utilizing the Micropolis Disk Drive as a System Resource," Master's Thesis, October 1982.

S. Vassiliou, A Distributed Network Supporting Ocean Surveillance," Master's Thesis, October 1982.

PROFESSOR UNO R. KODRES, DEPARTMENT OF COMPUTER SCIENCE HAS CON-
TINUED RESEARCH IN FY 1982 WITH PROFESSOR'S MITCHELL L. COTTEN AND
RUDOLPH PANHOLZER, DEPARTMENT OF ELECTRICAL ENGINEERING IN THE
DEVELOPMENT OF MULTI-MICROCOMPUTER BASED ARCHITECTURES.

Title:	Programming Language Metrics
Investigator:	Bruce J. MacLennan, Assistant Professor of Computer Science
Sponsor:	Office of Naval Research
Objective:	The purpose of this study is to: (1) develop ordinal, or qualitative, means of comparing languages according to some quality; these would allow ranking languages according to some quality, for instance, complexity; and (2) develop cardinal, or quantitative, means of evaluating languages; these would permit numeric measurement of specific language attributes.
Summary:	Since programming languages are the primary tools used in the programming process, it is not surprising that the choice of programming language is an important element of the life-cycle cost of a software development project. For this reason it is necessary to be able to compare languages and judge their suitability for various applications. Unfortunately, language comparison and evaluation remains a mostly subjective art not unlike literary criticism. This is unsatisfactory for a tool of the importance of a programming language.
	One promising approach to comparing languages is to compare the size of their grammars. Since a smaller, more regular language will tend to have a shorter grammar than a larger, less regular language, we can measure the size and regularity of a language by the size of its description in a grammar in an appropriate normal form.
	To date these methods have been used to measure the total complexity of several well-known languages, to compare the relative size of the subsystems of several languages, to measure the complexity of the execution sequences of a number of control structures, and to measure the semantic complexity of several parts of several languages.
Publications:	B. J. MacLennan, "Simple Metrics for Programming Languages," Information Processing and Management, forthcoming.
	B. J. MacLennan, "Measuring Control Structure Complexity Through Execution Sequence Grammars," submitted to Transactions on Programming Languages and Systems.

B. J. MacLennan, "Measuring Control Structure
Complexity Through Execution Sequence Grammars,"
NPS Technical Report, NPS52-81-015, November 1981.

B. J. MacLennan, Principles of Programming Languages:
Design, Evaluation and Implementation, New York:
Holt, Rinehart and Winston, forthcoming.

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PROFESSOR BRUCE J. MACLENNAN, DEPARTMENT OF COMPUTER SCIENCE HAS BEEN INVOLVED IN THE RESEARCH OF PROGRAMMING LANGUAGE METRICS AND RELATIONAL PROGRAMMING IN FY 1982.

Title: Relational Programming

Investigator: Bruce J. MacLennan, Assistant Professor of Computer
                    Science

Sponsor: NPS Foundation Research Program

Objective: Continued development of relational programming as an
                    advanced methodology for software development. Short
                    term objectives include: (1) discovery of the semantic
                    primitives of relational programming, (2) design of a
                    relational programming language, and (3) assessment
                    of the value of relational programming.

Summary: Relational programming is a method of programming
                    based on the use of a relational calculus. It is
                    well known that almost any data structure can be
                    described by a relation. In effect, then, any
                    operation on relations can be thought of as an
                    operation on data structures. Hence, the high-level
                    relational operators provided by a relational calculus
                    are a source of high-level operations for manipulating
                    linear and non-linear data structures.

                    Further, since every function is a relation, every
                    relational operator is in effect a functional
                    operator, i.e., a function that operates on other
                    functions. Therefore, the same set of operators that
                    are used for manipulating data can also be used for
                    manipulating programs. This permits the high-level
                    combination and manipulating of programs to yield
                    other programs.

                    Several tasks have been accomplished this year.
                    First, a set of relational operators has been settled
                    on. Second, we have developed two notations for
                    relational programming, one mathematical and one
                    non-mathematical. Third, we have investigated
                    several implementation strategies for relational
                    languages. Fourth, we have tried to assess the value
                    of relational programming by using it to implement
                    a major piece of software (a syntax-directed editor).
                    Finally, we have developed a theoretical basis for
                    accommodating databases and other time-varying objects
                    in relational languages.

Publications: B. J. MacLennan, "Introduction to Relational
                    Programming," Proceedings of ACM Symposium on
                    Functional Programming Languages and Computer
                    Architecture, New York: Association for Computing
                    Machinery, 1981.

B. J. MacLennan, "A Simple, Natural Notation for Applicative Languages," <u>Sigplan Notices 17</u>, 10, October 1982.

B. J. MacLennan, "Values and Objects in Programming Languages," <u>Sigplan Notices</u>, forthcoming.

B. J. MacLennan, "Overview of Relational Programming," NPS Technical Report, NPS52-81-017, November 1981.

B. J. MacLennan, "A Relational Program for a Syntax Directed Editor," NPS Technical Report, NPS52-82-006, April 1982.

B. J. MacLennan, "The Role of Objects in Applicative Languages," NPS Technical Report, in progress.

B. J. MacLennan, "A Simple Production System for Applicative Programming," NPS Technical Report, in progress.

Conference
Presentation: B. J. MacLennan, "Introduction to Relational Programming," ACM Symposium on Functional Programming Languages and Computer Architecture, Portsmouth, New Hampshire, October 18-22, 1981.

Theses Directed: S. Futaci, "Representation Techniques for Relational Languages and the Worst Cast Asymptotical Time Complexity Behavior of the Related Algorithms," <u>Master's Thesis</u>, June 1982.

O. D. Borcheller and R. Ross, "Functional Pascal: An Interim Solution to a Changing Direction in Programming Language Development," <u>Master's Thesis</u>, June 1982.

Title:	Advanced Work on an Algorithm Design Methodology
Investigator:	Douglas R. Smith, Assistant Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	To continue the development of a methodology for automatically constructing computer programs.

Summary:

A top-down approach to program synthesis has been developed. This research has involved several supporting activities.

1) investigation of the structure of the class of algorithms called "divide and conquer" resulting in a novel algebraic characterization.

2) formalization and implementation of a new form of deduction called precondition derivation.

Publications:

D. R. Smith, "Derived Preconditions and Their Use in Program Synthesis," 6th Conference on Automated Deduction, Ed. D. W. Loveland, Lecture Notes in Computer Science 138, Springer-Verlag, New York, pp. 172-193.

D. R. Smith, "Top-down Synthesis of Simple Divide and Conquer Algorithms," NPS Technical Report, NPS52-82-011TR, November 1982.

Conference
Presentation:

D. R. Smith, "Derived Preconditions and Their Use in Program Synthesis," 6th Conference on Automated Deduction, New York, NY, June 1982.

PROFESSOR DOUGLAS R. SMITH, DEPARTMENT OF COMPUTER SCIENCE HAS CONTINUED HIS WORK ON AN ALGORITHM DESIGN METHODOLOGY IN FY 1982.

DEPARTMENT

OF

MATHEMATICS

DEPARTMENT OF MATHEMATICS

The Mathematics Department of the Naval Postgraduate School is a service organization providing support for every other department in the school. As such, its program is designed to provide graduate education as well as undergradute education for students not completely prepared for their graduate curricula. The department helps the students develop the ability to relate fundamental principals to military applications, to reason logically, and to move quickly into technical areas in response to changing needs and technology.

Supplying the department's goals toward the development of the NPS students in their various curricula, the members of the department conduct research in several areas related to the mission of the school.

NUMERICAL ANALYSIS

On Surface Approximation from Scattered Data Points, R. H. Franke has been studying surfaces with sharp gradients along with Gregory Nielson of Arizona State University. Several conference reports and papers have resulted.

Together with T. Jayachandran, R. H. Franke has continued research into the efficacy of the Foutz multivariate goodness-of-fit test. Papers reporting on the performance of the test and giving approximate percentage points of the distribution of the test statistics have been written.

R. Franke has continued joint work with W. J. Gordon of Drexel University into interpolation/approximation of meteorological data. Together with G. Birkhoff he has been concerned with the behavior of stochastic differential equations.

A. L. Schoenstadt has been working with R. T. Williams and R. E. Newton to develop and test a finite element atmospheric prediction model. Two models were tested, one employing bilinear basic functions on rectangular elements and the other using linear functions on triangular elements. Several papers comparing these models with finite difference solutions for analytic initial conditions have appeared.

NUMERICAL FLUID DYNAMICS

R. Mendez has investigated the numerical simulation of flow past immersed compliant surfaces via two vortex methods. Comparisons of the methods on the same problem and against a linearization technique have been made. Similarities of the linearization technique to the vortex monopole method were noted. But each method has areas of application. Work continues on all methods and application of the vortex dipole method to inviscid flow past a parachute will be pursued.

CONVERGENCE TECHNIQUES

M. D. Humphries has been studying methods of accelerating algorithms that converge superlinearly to analyze their theoretical properties and to study their practicality.

MATHEMATICAL MODELING

M. Weir has been developing materials to enhance our ability to create mathematical models of complicated situations. Together with F. Giordano of the United States Military Academy, he has produced papers on modeling using the derivative and using dimensional analysis. A textbook emphasizing the process of mathematical modeling and its iterative/refinement nature is being prepared.

MICROPROCESSOR LAB

The mathematics microprocessor lab is now used in several courses. The software for these courses is continually upgraded. Thesis students are currently working on networking applications. A star and a ring network are anticipated. On a separate front, a menu driven modem program available to the users of the lab and others will soon be available. Overseeing all of these developments is G. Latta.

Other mathematical software has been developed by several members of the department. Notable is the work of C. O. Wilde who, together with several other researchers, is preparing a textbook of programs which will aid the student in the study of the calculus via interaction with a microcomputer.

DISCRETE MATHEMATICS

The application of discrete mathematics to problems of communication has been the concern of H. M. Fredricksen. He has pursued the development of sequences which can be used for secure communication and cryptographic purposes.

STATISTICAL ANALYSIS

T. Jayachandran continues to perform statistical tests with H. Larson to determine procedures to monitor aircraft engine wear. This ongoing project has resulted in a larger computerized Comprehensive Engine Management System for the Air Force.

The above have been conducting tests to develop advanced technology for nondestructive inspection of aircraft to detect hidden flaws before they can lead to catastrophic results. Preliminary reports into their findings and results have been submitted to the sponsor.

OPTIMIZATION

I. B. Russak has been working to establish a weakened set of hypotheses under which it can be guaranteed that certain types of non-linear optimization algorithms will converge and what the rates of convergence will be.

ACOUSTIC STUDIES

J. L. Wayman has been extending work of others on computer prediction of early-to-reverberant round ratios in rooms to include frequency dependent boundary conditions. Papers detailing this research have been presented before the Acoustical Society of America.

Title: Investigation of Objective Analysis Schemes

Investigators: Richard Franke, Associate Professor of Mathematics
                      and Garrett Birkhoff, Adjunct Professor of Mathema-
                      tics

Sponsor: Naval Environmental Prediction Research Facility

Objective: To investigate properties of schemes which are used,
                      or can be used, to interpolate or approximate
                      scattered data from meteorological sources.

Summary: Investigation of the properties of optimum interpo-
                      lation schemes has continued. These kinds of schemes
                      have arisen in diverse fields independently and have
                      been shown to be equivalent. The functional form of
                      the approximation and how the method accounts for
                      errors of varying magnitudes has been developed.

                      The effects of errors in the interpolation of calcu-
                      lated grid values to the observation points is under
                      investigation. Modifications to an existing simmula-
                      tion program due to Cohn and Ghil are in progress for
                      use in investigating how this interpolation process
                      affects the errors in the prediction.

Publications: Richard Franke and W. J. Gordon, "The Structure of
                      Optimum Interpolation Functions", in progress.

                      Garrett Birkhoff and Richard Franke, "Stochastic DE's
                      and Objective Analysis", in progress.

Title: Surface Approximation from Scattered Data Points

Investigator: Richard Franke, Associate Professor of Mathematics

Sponsor: None

Objective: To study and develop schemes for surface approxima-
                    tion when scattered data points are known. Focus on
                    schemes for ill-behaved, possibly discontinous (but
                    otherwise smooth) surfaces. This work is undertaken
                    jointly with G. M. Nielson, Arizona State University.

Summary: Two schemes for approximation of surfaces with known
                    lines of discontinuity were developed. These were
                    both based on a weighted sum of local approximations;
                    one incorporated the discontinuity into the weight,
                    the other into the local approximation. A scheme for
                    constructing a surface under tension was also deve-
                    loped. This allows the user to specify a tension
                    parameter which serves to control overshort/under-
                    short in the vicinity of sharp gradients.

Publications: Richard Franke and Gregory Nielson, "Surface Approxi-
                    mation with Imposed Conditions", Proceedings of
                    'Surfaces in CAGD', North-Holland (Forthcoming).

                    Gregory Nielson and Richard Franke, "Surface Construc-
                    tion Based upon Triangulations of Nonconvex, Multiply
                    Connected Regions", Proceedings of 'Surfaces in CAGD',
                    North-Holland (Forthcoming).

                    Gregory Nielson and Richard Franke, "A Method for
                    Construction of Surfaces under Tension", submitted to
                    Rocky Mountain Journal of Mathematics.

Conference   Richard Franke, "The Finite Element Method and Inter-
Presentations: polation of Scattered Data", American Mathematical
                    Society Winter Meeting (Special Session), Cincinatti,
                    Ohio, January 13-17, 1982.

                    Richard Franke and Gregory Nielson, "Surface Approxi-
                    mation with Imposed Conditions", Surfaces in Computer
                    Aided Geometric Design, Oberwolfach, West Germany,
                    (by invitation only), April 26-30, 1982.

Gregory Nielson and Richard Franke, "Surface Construction Based upon Triangulations of Nonconves, Multiply Connected Regions", Surfaces in Computer Aided Geometric Design, Oberwolfach, West Germany (by invitation only), April 26-30, 1982.

Gregory Nielson and Richard Franke, "Triangular Patch Techniques for Scattered Data Interpolation", SIAM 30th Anniversary Meeting, (Mini-symposium on Surfaces), Stanford University, July 19-23, 1982.

Title: Application of Shift Register Sequences to Problems
                    of Communication

Investigator: H. M. Fredricksen, Associate Professor of Mathematics

Sponsor: Department of Defense

Objective: To perform analyses of the shift register sequences
                    to include their generation, properties and capabilities
                    for communications applications.

Summary: Secure communication demands that the communicator
                    continually develop more sophisticated signalling sets
                    to thwart attempts of an intelligent adversary. The
                    shift register sequences of non-linear type investigated
                    offer promise of an enhanced capability in this arena.

Publications: H. M. Fredricksen, "A Survey of Full Length Nonlinear
                    Shift Register Cycle Algorithms", SIAM Review, Vol. 24,
                    #2, April 1982, pp. 195-221.

                    H. M. Fredricksen and R. A. Wishiewski, "On Trinomials
                    x^n+x^2+1 and $x^{8\ell\pm3}+x^k+1$ irreducible over GF(2)",
                    Information and Control, Vol. 50, #1, July 1981,
                    pp. 58-63.

Title: Acceleration of Convergence of Iterative Algorithms

Investigator: Michael D. Humphries, Adjunct Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: To find methods of accelerating algorithms that converge superlinearly, to analyze their theoretical properties, and to study their practicality.

Summary: There are many iterative methods for solving nonlinear equations. There is a standard technique for accelerating the rate of convergence of an iterative method that converges linearly (slowly). The most appropriate methods for solving these problems converge faster than linearly. General techniques of accelerating the rate of convergence of iterative methods that converge superlinearly were developed. These techniques were applied to various methods of solving equations, yielding new, more rapid methods. Some of these were already known; the general approach provided a unified framework for them. Others are apparently new; their rates of convergence were determined. They proved to be more efficient than the traditional method in wide use. This was confirmed by experiment with numerical examples.

Publication: Michael D. Humphries, "The Acceleration of Superlinear Convergence", in progress.

Title: JOAP Analysis

Investigators: Toke Jayachandran, Associate Professor of Mathematics
                    H. J. Larson, Professor of Operations Research

Sponsor: Kelly Air Force Base

Objective: Develop statistical methodology for automatic
                    computer evaluation of the spectrometer readings on
                    oil samples.

Summary: JOAP is a tri-service program to use spectrometric
                    oil analysis as a tool to monitor the wear condition
                    of aircraft engines and other military equipment.
                    This is a continuing research project and this
                    year we have been developing statistical procedures
                    for the incorporation of oil analysis in a larger
                    computerized Comprehensive Engine Management System
                    (CEMS) being developed for the Air Force. The
                    project is expected to be continued into next year
                    to investigate the use of statistical tools on
                    other aspects of the CEMS program.

Publication: Toke Jayachandran and H. J. Larson, "Statistical
                    Methods for the Joint Oil Analysis Program," NPS
                    Technical Report, NPS55-82-002, January, 1982.

Title: Statistical Analyses for the NDI Technician Proficiency
                    Study

Investigators: Toke Jayachandran, Associate Professor of Mathematics
                    H. J. Larson, Professor of Operations Research

Sponsor: Kelly Air Force Base

Objective: Develop a methodology for grading the NDI technicians
                    based on their ability to detect flaws in aircraft bodies.

Summary: NDI is an advanced technology for nondestructive
                    inspection of aircraft to detect hidden flaws before
                    they can lead to catastrophic results. Ensuring the
                    proficiency of the NDI technicians is an important
                    aspect of the Air Force NDI program. The technicians
                    are periodically tested - we have been tasked to
                    develop a) proficiency ranking of the technicians,
                    b) a grading scheme for the technicians, and
                    c) confidence bounds for the probability of detecting
                    cracks of a specified size.

Title: Fundamental Frequencies of Oscillation of an
                          Immersed Elastic Boundary

Investigator: Raul Mendez, Adjunct Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: Testing of the Vortex Dipole Algorithm. Estimate
                          fundamental frequencies of oscillation of an
                          immersed elastic boundary. Compare these estimates
                          against those obtained via linearization of
                          equations of motion.

Summary: Agreement was obtained between computed and predicted
                          frequencies (obtained via linearization) for small
                          amplitudes of the boundary's oscillation, for
                          larger amplitudes the two methods failed to agree.
                          This disagreement was predictable in view of the
                          basic assumptions underlying the linearization.

Publications: R. Mendez, "Fundamental Frequencies of Oscillation
                          of an Immersed Elastic Boundary," SIAM Journal of
                          Statistics and Scientific Computing, forthcoming.

                          R. Mendez, "Fundamental Frequencies of Oscillation
                          of an Immersed Elastic Boundary," NPS Technical
                          Report, forthcoming.

Conferences
Presentation: R. Mendez, "Fundamental Frequencies of Oscillation of
                          an Immersed Elastic Boundary," preliminary version of
                          this work presented at 1981 SIAM Meeting, Rensselaer
                          Polytechnical Institute, June 6, 1981.

Title: Numerical Modelling of Transonic Flow Past Cascade
                    Blades Via Higher Order Godunov Methods

Investigator: Raul Mendez, Adjunct Professor of Mathematics,
                    S. Eidelman, NRC Postdoctoral Research Associate

Sponsor: NPS Foundation Research Program and Office of Naval
                    Research

Objective: To develop a numerical scheme capable of simulating
                    flow past cascade blades.

Summary: Design and testing of a numerical scheme for computing
                    transonic flow past cascade blades. Numerical
                    scheme is based on higher order approximations to
                    the compressible Euler's equations. The scheme is
                    based on Van Leer's monotonicity interpolation
                    scheme as well as on Collela-Woodward's MUSCL scheme.

Publications: S. Eidelman and R. Mendez, "Numerical Modelling of
                    Transonic Flow Past Cascade Via Higher Order Godunov
                    Methods," Journal of Computational Physics, submitted
                    for publication.

                    S. Eidelman and R. Mendez, "Numerical Modelling of
                    Transonic Flow Past Cascade Via Higher Order Godunov
                    Methods," NPS Technical Report, forthcoming.

Conference
Presentation: S. Eidelman and R. Mendez, "Numerical Modelling of
                    Transonic Flow Past Cascade Via Higher Order Godunov
                    Methods," to be presented at AIAA Meeting, University
                    of California, Davis, May 1983.

Title: Numerical Solution of The Interior Neumann Problem
                  Via Vortex Dipoles

Investigator: Raul Mendez, Adjunct Professor Mathematics

Sponsor: NPS Foundation Research Program

Objective: Testing of a numerical scheme designed to compute
                  potential flows on irregular regions via tangential
                  vortex dipole layers. The scheme is based on an
                  approximation to a Fredholm integral of the second
                  kind obtained by computing the Neumann sum via
                  discrete vortex dipole layers.

Summary: The method was tested on an irregular region simulating
                  an aortic sinus cavity. The data for the Neumann
                  problems was generated via Chorin's discrete vortex
                  method. The method succeeded in producing a potential
                  flow that, when superimposed on Chorin's flow, led
                  to no fluid seepage or leakage at the wall.

Publication: R. Mendez, "Numerical Solution Of The Neumann Problem
                  Via Vortex Dipoles," NPS Technical Report, Forthcoming.

Conference
Presentation: R. Mendez, "Numerical Solution Of The Neumann Problem
                  Via Vortex Dipoles," SIAM National Meeting, North
                  Carolina State University at Raleigh, North Carolina,
                  April 1982.

Title:	The Vortex Monopole Algorithm: Representation of Elastic Forces Applied to Incompressible Inviscid Fluids
Investigator:	Raul Mendez, Adjunct Professor of Mathematics
Sponsor:	NPS Foundation Research Program
Objective:	Testing of the Vortex monopole algorithm. Estimate frequency of oscillation of immersed elastic boundary and compare against estimates obtained via vortex dipole algorithm as well as predicted frequencies obtained via linearization. Test new algorithm for computing boundary forces via spline approximation.
Summary:	Excellent agreement was obtained between the three methods for small amplitudes of oscillation. The new method, however, requires approximately one third less computer effort per iteration, while simulating the physical properties of the system with improved accuracy.
Publications:	R. Mendez, "The Vortex Monopole Algorithm: Representation of Elastic Forces Applied to Incompressible Inviscid Fluids," SIAM Journal of Statistics and Scientific Computing, Submitted for publication. R. Mendez, "The Vortex Monopole Algorithm: Representation of Elastic Forces Applied to Incompressible Inviscid Fluids," NPS Technical Report, forthcoming.
Conference Presentation:	R. Mendez, "The Vortex Monopole Algorithm: Representation of Elastic Forces Applied to Incompressible Inviscid Fluids," SIAM National Meeting, June 1983, Boulder, Colorado.

Title: Convergence of Non-Linear Optimization Algorithms
Under Weakened Hypotheses

Investigator: I. B. Russak, Associate Professor of Mathematics

Sponsor: None.

Objective: To establish a weakened set of hypotheses under which
it can be guaranteed that certain types of non-linear
optimization algorithms will converge. Also to
determine what the convergence rates are.

Summary: Consider the general constrained optimization problem

minimize $f(x)$
subject to
$g_\alpha(X) \leq 0$ $\alpha=1,\ldots m'$ $g_\alpha(X)=0$ $\alpha=m'+1, \ldots, m$

where X is an N-dimensional vector. Real world appli-
cations of this problem occur very frequently in military
applications, e.g. optimizing with respect to time
to intercept, the parameters of a missile inteceptor
system subject to constraints on its motion. Often,
however, the restrictive conditions assumed in many con-
vergence proofs of numerical algorithms for solving
problems of this type are not true. It may, therefore,
be incorrect to apply such algorithms in those cases.
A weakened set of hypotheses which more accurately
represents the real world situation is being developed
and convergence rates under these modified conditions
are being investigated.

Title: Determination of Frequency Dependent Early-To-
                    Reverberant Sound Ratios Using Ray Tracing Methods

Investigator: J. L. Wayman, Adjunct Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: To extend earlier work by others on computer predic-
                    tion of early-to-reverberant sound ratios in rooms
                    to include frequency dependent boundary conditions.

Summary: The early-to-reverberant sound ratio has been put
                    forth by many researchers as a design index for pre-
                    dicting speech intelligibility in rooms. Computer
                    implemented ray methods can be used to predict these
                    ratios from room specifications. Santon (JASA, Vol. 59,
                    No. 6, 1976) applied the ray model in this manner.
                    This study extended Santon's work by considering the
                    frequency-dependence of the boundary acoustic imped-
                    ances, and showed that the ray method can be used to
                    predict frequency-dependent early-to-reverberant
                    sound ratios.

Conference
Presentation: J. L. Wayman, "Determination of Frequency Dependent
                    Early-to-Reverberant Sound Ratios in Enclosures",
                    103rd meeting of the Acoustical Society of America,
                    Chicago, Illinois, 26-30 April 1982.

DEPARTMENT

OF

ADMINISTRATIVE SCIENCES

DEPARTMENT OF ADMINISTRATIVE SCIENCES

The Administrative Sciences Department is the Naval Postgraduate School's organizational unit responsible for academic programs designed to educate officers and DoD civilians in a variety of functional management specialties. As such, it is a large, multi-disciplinary department with diverse research projects oriented to support management tasks within the Navy and the Department of Defense. For ease of exposition the research program may be divided into the following (sometimes overlapping) areas of research concentration: Acquisition, Information, and Logistics Systems; Organizational Sciences; Financial/Resource Management; and Manpower, Personnel and Training. The past year's focus of the specific research projects in these areas is summarized in the following paragraphs.

ACQUISITION, INFORMATION, AND LOGISTICS SYSTEMS

C. R. Jones continued his research into the behavior of defense contractors and the peculiarities of this industry structure for defense contracting. D. Boger continued his investigation of the relationship of internal firm organization and financial performance. Professors Boger and Jones, in conjunction with Professor K. Sontheimer of the University of Pittsburg, continued an examination of the incentive effects present in long-run contractual arrangements. M. B. Kline continued his research in systems engineering and the systems acquisition process areas, including analysis of maintainability, active repair time, and suitability of logistics provisioning, level of repair, and life support cost models for optimizing logistics resources. N. Lyons continued working on man-machine interface problems in the C3 area. N. F. Schneidewind continued his research in the areas of software engineering and management, and his involvement in the design of computer-communications networks in support of Naval logistics systems. R. Weissinger-Baylon continued his research on the function of visual mental imagery in problem solving and decision making. A. W. McMasters continued his research on methods to assist the Naval Electronic Systems Command in determining when to transfer control of inventories of items to the Ships Parts Control Center. Professor McMasters also continued his work on the development of an improved local delivery system for Naval Supply Centers at Oakland and Norfolk. He also continued his analysis of hotel steam flow rate data to determine the amount of steam needed by ships in port. J. W. Creighton continued his research on the technology transfer process. C. Eoyang, N. Lyons, and J. Wozencraft (EE) began a study of the information handling aspects of C3 in terms of Battle Assessment. Professor McMasters, in conjunction with F. Richards and G. Howard (OR), developed and evaluated uniform provisioning criteria for FMSO.

ORGANIZATIONAL SCIENCES

C. K. Eoyang, R. T. Harris, R. McGonigai and W. R. Bishop continued the long term research program in organization development. Their extensive field work underlies significant contributions of the revitalization of the Navy's program in Human Resource Management, which is the largest in the country. P. Bromiley continued his examination of regulatory priority setting by mid-level employees. M. R. Louis continued her research into the dynamics of career transitions, developing a framework for diagnosing transition situations and identifying common tasks to be accomplished by newcomers. R. Evered continued his research in both the Strategic Management area and the epistemology of social science research. D. Whipple and J. LaPatra continued the investigation of the existence of an interdisciplinary predictive theory of intra-firm behavior. J. D. Senger continued his investigation of authoritarian attitudes among U. S. and allied military officers.

FINANCIAL/RESOURCE MANAGEMENT

Professors Whipple, LaPatra, and Bromiley began an evaluation and analysis of the structure of the DoD Productivity Enhancement Program. D. Boger, N. Lyons, and J. Hayes began a survey of productivity enhancement techniques at the Fleet Material Support Office's Information Processing facilities. K. J. Euske continued his research on the behavioral effects generated by the budgetary process. Professors Boger and Whipple began a preliminary investigation of the potential relationship between U. S. coal reserves and a "market-based" defense strategy. Professors Euske and Louis began an investigation of the major factors affecting the effectiveness of Navy management control systems. J. M. Fremgen and D. Boger began an effort to determine the classifications, composition and allocation of overhead costs in major aerospace defense contractors. P. Bromiley continued his study of the determinants of corporate capital investment. S. S. Liao continued his study of the feasibility of using cost accounting and program accounting techniques to measure the performance of general governmental operations. Professor W. Greer continued his long-range research on the relationship between the structure of information and the quality of decision making. E. R. Brubaker completed his research effort to measure experimentally the variation in demand disclosures. Professors Liao and Greer began an analysis of sole source versus dual source system procurement of advanced weapons systems.

MANPOWER/PERSONNEL/TRAINING RESEARCH

R. S. Elster began implementation of a program of research development which is designed to lead to the establishment of a Manpower Research Center at NPS. To this end a number of new research faculty were added and the

existing program of research broadened. Professor G. Thomas began a project to assess the feasibility of modeling the supply of older age accessions. Professor Thomas continued his work on the development of models of career-ist retention behavior. Professors Thomas and Liao also studied the impact of economic factors on the reenlistment decisions of career petty officers. R. A. Weitzman continued his research on the application of sequential aptitude testing for recruit selection and assignment and his research into development of predictive techniques useful in manpower/personnel research. In addition, Professor Weitzman, F. Horton, and T. Sticht began a study of methods to streamline the Instructional Systems Development process.

Title: A Productivity Enhancement Study of the FMSO
Information Processing Facilities

Investigators: Dan C. Boger, Assistant Professor, Administrative
Sciences, Norman R. Lyons, Associate Professor,
Administrative Sciences, LCDR John R. Hayes,
Instructor, Administrative Sciences

Sponsor: Fleet Material Support Office.

Objective: Survey the productivity enhancement techniques
in use at FMSO, compare these with measures in
use in industry, and develop a productivity
enhancement implementation strategy.

Summary: This is an on-going project, hopefully the first
in a series of studies for FMSO. In the initial
study, we will identify areas in the software
development work at FMSO that are candidates
for productivity improvement. The initial
research is going to outline the measures that
need to be taken in a productivity improvement
program. Follow on work will begin the data
gathering and implementation to support this
work.

Title: A Behavioral Examination of Corporate Capital Invest-
                          ment

Investigator: Philip Bromiley, Assistant Professor of Administrative
                          Sciences Department

Sponsor: NPS Foundation Research Program

Objective: To increase our understanding of the determinants of
                          corporate expenditures on property, plant and equip-
                          ment.

Summary: Based on the interviews and data analysis from four
                          large corporations, research considered the impli-
                          cations of corporate operating procedures on capital
                          investment. Corporate planning and implementation
                          procedures were described, hypotheses concerning the
                          implications of such tested, and a conceptual frame-
                          work for the determinants of capital investment pro-
                          duced.

Publications: Philip Bromiley, "The Determinants of Corporate
                          Çapital Investment: A Behavioral Approach," in pro-
                          gress.

                          Philip Bromiley, "Comparison of Behavioral and Neo-
                          Classical Conceptions of Investment," in progress.

                          Philip Bromiley, "A Summary of 'A Behavioral Investi-
                          gation of Corporate Capital Investigation,'" in pro-
                          gress.

Conference
Presentation: Philip Bromiley, "The Impact of Organizational Pro-
                          cesses on Strategic Action: The Capital Investment
                          Decision," submitted to Strategic Management/Business
                          Policy International Symposium.

Title: Demand Disclosures and Conditions on Exclusion: An Experimental Investigation

Investigator: Earl R. Brubaker, Adjunct Professor of Administrative Sciences Department

Sponsor: National Science Foundation

Objective: Measure experimentally variation of demand disclosures with variation of conditions on exclusion.

Summary: Variations in disclosures of individual demands as a function of material and nonmaterial incentives were measured experimentally. Participants responded to offers of goods under terms characterized by: (1) strict individual material incentive for disclosure; (2) strict material incentive for nondisclosure; (3) material incentive neither for disclosure nor for non-disclosure; and (4) an ordinary collective decision situation modified by several elements designed to reduce the material incentive for nondisclosure.

Revelations of demand varied directly with the degree of material incentive, but nonmaterial motives apparently also significantly affected responses. The effects of repetition differed markedly in response to decision situations (2) and (3). Responses to decision-situations (1), (2), and (4) were unimodal, bimodal, and trimodal, respectively, perhaps reflecting the distribution in the population of the relative strength of material and nonmaterial values.

Testable and tested hypotheses relevant to the trade-offs between material and nonmaterial values appear to be an essential next step in understanding behavior in collective economic decision situations. Responses to (3) were consistent with the hypothesis that individuals will disclose demands accurately provided that doing so results in no appreciable loss of opportunity for material gain. If so, effective collective decision procedures avoiding complexities associated with creating strict material incentive for accurate disclosure may be possible.

Title: The Use of Competition on Five Army Acquisition Pro-
                    grams

Investigator: P. M. Carrick, Associate Professor, Department of
                    Administrative Sciences

Sponsor: Office of the Secretary of Defense: Defense Director
                    of Research and Engineering

Objective: Assess use of competition, its cost and benefits on
                    five current acquisition programs; the Bradley FVS;
                    the Copperhead projectile; the DIVAD; the MLRS and
                    the Viper anti-tank program.

Summary: The actual and possible uses of competition in R & D
                    as well as production assessed.

Publication: P. M. Carrick, "Competition as an Acquisition Strategy:
                    An Assessment of Selected Army Weapon Systems Procure-
                    ment," Institute for Defense Analyses (September 1982),
                    p. 227.

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Title: Enhancement of Effectiveness of R & D Investments
                  of the Naval Facilities Engineering Command

Investigator: J. W. Creighton, Professor of Administrative Sciences
                  Department

Sponsor: Naval Facilities Engineering Command

Objectives: As a continuing project the primary objective during
                  15 prior years has been to enhance the effectiveness
                  of Naval Facilities Engineering Command R & D activi-
                  ties. The primary specific objective of this years
                  work was largely concentrated in surveying and evalu-
                  ating means by which the engineering manager might
                  increase his effectiveness through wise use of inno-
                  vations.

Summary: Primary effort in the past has been directed toward
                  the contributions which might be made by the NAVFAC
                  research organizations toward effective technology
                  transfer. Choice of research projects and the docu-
                  mentation and distribution of research results have
                  been major concentration areas. As the research
                  branch has become more responsive, there has been grow-
                  ing an increased awareness on the part of civil engin-
                  eers in the field of the potential for assistance.
                  The pull for new technology has increased. The FY 82
                  effort was largely concentrated in surveying and eval-
                  uating means by which the engineering manager might
                  increase his effectiveness through wise use of inno-
                  vations. Focus has thus been on the ever present need
                  to take advantage of new technologies.

Publication: J. W. Creighton, "The Manager's Role in Technology
                  Transfer," In Naval Facilities Engineering Command
                  and U.S. Forest Service, forthcoming.

Title: NAVSTAR Global Positioning and Nuclear Detection
                System (GPNDS) Program Continued Phase III Acquisition
                Strategy and Production Procurement Options Support

Investigator: W. H. Cullin, Adjunct Professor of Acquisition Manage-
                ment, Department of Administrative Sciences

Objective: To provide continued support of the NAVSTAR GPNDS Pro-
                gram in the development of Acquisition Strategy and
                procurement options for Phase III production contracts.

Summary: The development of an Acquisition Strategy for the
                Phase III acquisition of the user equipment segment
                of the GPNDS has continued during this reporting period.
                A series of meetings have been held at the NAVSTAR
                GPNDS Joint Program Office to develop the Acquisition
                Strategy Document that is required to support the
                DSARC III and Milestone III production decision
                scheduled for 1984.

                A format has been developed with commonality, competition,
                Host Vehicle integration, maintenance concepts and
                system configuration being elements of the Acquisition
                Strategy considered. Supplemental and concurrent work
                on the SOW, RFP and CDRL's have been initiated. Con-
                sultations have been made with supporting activities
                (i.e., NADC, JSSMO, NAC and Contractors) in the de-
                velopment of the Acquisition Strategy. Guidance and
                direction for this effort have been obtained from the
                DoD 5000 series, GPS Program Management Directive,
                20 Sept. 1982 and the GPS Decision Coordinating Paper
                (DLP) 133.

Title: Development of Enlistment Standards for Navy Ratings

Investigators: R. S. Elster, Professor, Mark Eitelberg, Bill McGarvey,
                        and Paul Hoffman, Adjunct Professors, Department of
                        Administrative Sciences

Sponsor: Navy Personnel R & D Center

Objective: To develop enlistment standards for all Navy entry-
                        level enlisted ratings.

Summary: Work on this project is underway. An integrated data
                        base formed from four separate subfiles has been
                        formed at DMDC. Statistical analyses - yielding the
                        enlistment standards - are about to begin.

Title: Battle Assessment for C3

Investigators: Carson K. Eoyang, Associate Professor, Adminis-
trative Sciences, Norman R. Lyons, Associate
Professor, Administrative Sciences and John M.
Wozencraft, Professor, Electrical Engineering
and Chairman of the C3 Program

Sponsor: Naval Electronic Systems Command

Objective: The objective of the research was to study the
information handling aspects of C3 and determine
their impact on the outcomes of battles. As the
research developed it was clear that there was
a great deal of basic work that had to be done
with gaming environments before detailed experi-
mentation and training work could begin.

Summary: Our work with the Warfare Environment Simulator
(WES) indicated a number of serious problems
with the software. The developers were constantly
working on the next version of the system so
that during the life of the project, we were
working with unstable software and inadequate
documentation. Nevertheless, we were able to
make a number of runs with the system and were
able to offer some insights into how wargaming
should be conducted. Points that came out of
the research included:

1. Work with the user interface.

   a. More flexible types of user interface
      are needed. Possibilities include voice
      input and menu input with single keystroke
      or cursor selection.

   b. Files of pre-planned orders need to be
      developed so that a user can invoke a
      whole block of actions through a single
      command.

   c. Some sort of centralized terminal startup
      program would be useful to handle the
      complicated wargame environment setup.

2. Level of game detail.

   a. WES is far too demanding on its players.
      They need to be familiar with a highly
      structured set of WES commands as well
      as the warfare environment. Future war-
      games should concentrate on ways of

making this interface easier on their
players.

3. Level of realism.

    a. The original focus on the research had
        been on the impact of communication
        problems on battle outcome. There were
        a number of problems in the implementation
        of WES message handling that made this
        impractical. For instance, communication
        problems like garbled messages or jamming
        could not be simulated directly in WES.
        The structure of WES needs revision
        before it can be adequately used in this
        type of research.

Title:	Three Conceptions of Strategy: Comparisons and Integration
Investigator:	Roger Evered, Associate Professor of Administrative Sciences
Sponsor:	NPS Foundation Research Program
Objectives:	To systematically contract the three conceptualizations of strategy in the three fields of Business/Corporate, Military/Diplomatic and Futures Research/Futuristics. The purpose is to enable each of these three fields to benefit from the ways in which the two other fields frame their strategy concepts, and to seek ways of synthesizing the three conceptual frameworks.
Publications:	Roger D. Evered, "Contrasting Conceptions of Strategy," NPS Technical Report, NPS54-81-021TR, December 1981. Roger D. Evered, "Just What is Strategy: Three Contrasting Concepts," Long Range Planning Vol. 16 No. 3 Forthcoming.
Conference Presentation:	Roger D. Evered, "Contrasting Conceptions of Strategy," Non Traditional Approaches to Policy Research, University State of California, Los Angeles, November 1981.

Title:	Development of Descriptive Models of Overhead Costs in Selected NAVAIR Prime Contractors
Investigators:	James M. Fremgen, Professor of Accounting, Department of Administrative Sciences, and Dan C. Boger, Assistant Professor of Economics, Department of Administrative Sciences
Sponsor:	U.S. Navy Center for Acquistition Research
Objective:	To Determine the Classifications, Composition, and allocation of overhead costs in major aerospace defense contractors. The objective of this phase of the project was to describe overhead cost behavior in selected firms and to make a preliminary assessment of the feasibility of analytical models for predicting overhead behavior.
Summary:	The research completed to date has identified the overhead pools used, their composition, and their allocation bases. It has revealed the ways in which the contractors budget principal costs categories. It has also identified several circumstances and problems which will affect efforts to develop analytical models.

Title: Human Resource Management System: Research and Support
                     Project (current)

Investigators: Reuben T. Harris, Associate Professor of Management,
                     Department of Administrative Sciences and Carson K.
                     Eoyang, Associate Professor of Management, Department
                     of Administrative Sciences

                     Associate Investigators:

                     Richard McGonigal, Associate Professor of Management
                     CDR Richard Bishop, Instructor in Management
                     Miguel Tirado, Adjunct Professor of Management

Sponsor: Chief of Naval Operations,
                     Naval Military Personnel Command

Objective: To provide continuing research, analysis, training and
                     consultation support to the U.S. Navy's Human Resource
                     Management Support System (HRMSS) at both field and
                     staff levels.

Summary: Since FY 79, numerous activities were conducted under
                     this project in support of the above objective. Two
                     long-term demonstration projects were undertaken with
                     the goal of improving the capability of HRMC's and
                     documenting the strategy and outcomes of those efforts.
                     The two project sites are HRMC San Diego and HRMC
                     Pearl Harbor. Also NPS faculty have delivered train-
                     ing activities at HRMC's and HRMD's at Pearl Harbor,
                     San Diego, Alameda, Norfolk, Charleston, Washington,
                     D.C., and NPS. NPS faculty planned and managed the
                     Military HRM Symposium held at NPS (November 1978).
                     Finally, NPS faculty designed and delivered annually
                     since 1979 a two-week Advanced OD Course for HRMC OD
                     Specialists.

                     Regarding activities of the past year, the major thrust
                     has been in three areas. First, several research pro-
                     jects (including theses) have been undertaken to pro-
                     vide the sponsor with knowledge and guidance in several
                     important policy-making arenas. Included was a major
                     project examining the dynamics of leadership in heter-
                     ogeneous work groups within Navy commands directed by
                     Professors R. McGonigal and M. Tirado. Secondly,
                     significant resources were employed in delivering ad-
                     vanced conceptual and skill training in OD to consul-
                     tants in the Navy's HRMSS. These included a two-week
                     course (60 participants) at NPS and on-site training
                     in WestPac, Europe and throughout CONUS. Finally, NPS
                     faculty have provided the sponsor with personal con-
                     sultations regarding OP-15/NMPC-6 efforts directed at
                     reorganization of the Navy's HRMSS.

Publication: R. McGonigal and M. Tirado, "Management Competencies
                    Particularly Relevant to Heterogeneous Work Groups in
                    the Navy,"(forthcoming NPS Technical Report, June 1983).

Conference
Presentation: R. T. Harris and C. K. Eoyang, "Organizational Effec-
                    tiveness in the U.S. Navy," Advanced HRM Training Pro-
                    gram, Monterey, CA, November 30 - December 10, 1981.

Thesis Directed: M. M. Gettys and A. G. Maxwell, Jr., "Organizational
                    Effectiveness: A Comparative Analysis Between Army
                    and Navy Officers," Master's Thesis, December 1981.

Title: Analysis of Corrective Maintenance Active Repair
                      Time Data

Investigator: M. B. Kline, Professor, Department of Administrative
                      Sciences

Sponsor: NPS Foundation Research Program

Objective: To continue analysis of active corrective maintenance
                      repairtime data from previous research to include
                      non-electronic systems as well as more recent elec-
                      tronic systems which use advanced digital techniques
                      such as digital diagnostics and built-in-test with
                      respect to the suitability of the lognormal or ex-
                      ponential distributions as an estimator of repair-
                      times.

Summary: Data on mechanical systems and components such as
                      helicopters, nuclear energy generation equipment
                      (pumps, cooling components, extractors) and more re-
                      cent electronic systems has been collected and ana-
                      lyzed using various statistical data analysis methods.
                      The previous research established that the lognormal
                      distribution was a more suitable description for re-
                      pairtimes than the exponential distribution for
                      electronic items.

Thesis Directed: E. Camozv, "A Study of the Application of the Log-
                      normal and Gamma Distributions to Corrective Main-
                      tenance Repair Time Data," Master's Thesis, September
                      1982.

Title: Comparison of DoD Weapon System Level-of-Repair Models

Investigator: M. B. Kline, Professor, Department of Administrative
                Sciences

Sponsor: Office of the Assistant Secretary of Defense
                (Manpower, Reserve Affairs and Logistics)

Objective: To perform comparative studies and analyses of selected
                level-of-repair models with regard to input require-
                ments, computational aspects, measures of cost-effec-
                tiveness used, and output information using a repre-
                sentative repair level and system structure as a
                test basis.

Summary: A list of candidate provisioning and level-of-repair
                models has been developed and documentation on them
                is being accumulated. A set of selection criteria
                is being developed in order to determine which models
                will be included in the study. The research study
                will continue through FY 83.

Title: Cost Accounting and Analysis for General Governmental
                    Operations

Investigator: Shu S. Liao, Associate Professor, Department of
                    Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To develop a general framework for a cost accounting
                    system for general governmental operations by inte-
                    grating policy-setting, program budgeting, output
                    measurement, and cost accounting techniques.

Summary: Using municipal government organization as a model,
                    this study developed methods of integrating policy-
                    setting, service delivery, and performance evaluation
                    in an accounting system. The primary purpose of such
                    an accounting system is to generate useful information
                    for governmental managers and policy makers. The
                    accounting system also facilitates the preparation of
                    an operating statement called for by the Financial
                    Accounting Standards Board.

Thesis Directed: Keith A. Johnson, "An Analysis of Local Management
                    Code Sorting of the Job Order Status Report for Use
                    in Public Works," Master's Thesis, June 1982.

Title: Economic Factors and the Retention of Military Career-
                    ists

Investigators: Shu S. Liao, Associate Professor of Administrative
                    Sciences Department and George Thomas, Adjunct Pro-
                    fessor of Administrative Sciences Department

Sponsor: Navy Personnel Research and Development Center

Objective: To study the impact of economic factors on the re-
                    enlistment decisions of career petty officers in the
                    Navy.

Summary: Reenlistment statistics for each Navy rating were
                    analyzed to identify factors contributing to the
                    variation in the reenlistment rates. The result of
                    multivariate analyses shows that the national unem-
                    ployment rate was the dominant factor affecting the
                    reenlistment rate. Pay was a significant factor for
                    only a few ratings. The length of service also was
                    an important factor in predicting an enlistee's re-
                    enlistment behavior. The regression models were tested
                    with three quarters of new data. The test result shows
                    that the predictive ability of the model is very high.

Publication: Shu S. Liao and George Thomas, "Economic Factors and
                    the Retention of Military Careerists," submitted for
                    publication.

Title: Career Transition Agenda: Identifying What is
                    Accomplished in Adapting to a New Job (part 2 of a
                    2-part project)

Investigator: Meryl Reis Louis, Associate Professor of Management,
                    Administrative Sciences Department

Sponsors: The Research Board, The University of Illinois, Urbana-
                    Champaign (8-78-6/79)
                    NPS Foundation Research Program

Objective: This study is part of a continuing research program,
                    the overall aims of which are to expand our understand-
                    ings of career transitions and the sense-making pro-
                    cesses by which newcomers cope with their experiences.
                    The current phase of the research was designed to ident-
                    ify fundamental tasks which newcomers accomplish in
                    completing career transitions.

Summary: To date the research has resulted in the formulation
                    of: 1) a model of cognitive processes by which indi-
                    viduals cope with transition experiences; 2) a con-
                    ceptual framework distinguishing among features of
                    transition experiences; 3) a typology of career tran-
                    sition situations; 4) an agenda of fundamental career
                    transition tasks; 5) a mapping of typical resources
                    and strategies available to newcomers for accomplish-
                    ing fundamental transition tasks. In addition, cul-
                    tural aspects of organizational life relevant to new-
                    comers have been described, as have more general aspects
                    of culture in organizational settings.

Publications: Meryl Louis, "Managing Career Transitions: A Missing
                    Link in Career Development," Organizational Dynamics,
                    Spring 1982, 68-77.

                    Meryl Louis, "A Cultural Perspective on Organizations,"
                    Human Systems Management, Vol. 2 No. 4, December 1981,
                    246-258.

                    Book review of Sociological Paradigms and Organizational
                    Analyses, by Gibson Burrell and Gareth Morgan, Forth-
                    coming in Administrative Science Quarterly, March 1983.

Conference
Presentations: Meryl Louis, "Career Transitions and Coping with Life
                    Events," NATO Conference on Role Transitions, Madison,
                    Wisconsin, September 1982, Co-authored with Marc Sokol.

                    Meryl Louis, "A Sense-Making Problematique in the
                    Organizational Sciences," International Congress of
                    Applied Psychology, Edinburgh, July 1982.

Meryl Louis, "Toward a System of Inquiry on Organizational Culture," An invited address to the Western Academy of Management, Colorado Springs, April 1982.

Meryl Louis, "Useful Knowledge and Knowledge Use: Toward Explicit Meanings," Useful Knowledge, University of Pittsburgh, October 1982.

Title: An Investigation of Factors Affecting Financial Control
                    in Navy Systems

Investigators: Meryl Louis, Associate Professor of Management, Admin-
                    istrative Sciences Department and Kenneth J. Euske,
                    Assistant Professor of Acccounting, Administrative
                    Sciences Department

Sponsor: Office of Naval Research

Objective: The objective is to investigate the effects of differ-
                    ent environmental factors upon the degree of differen-
                    tiation and integration necessary for an effective and
                    efficient management control system.

Summary: The project as designed would take two years to com-
                    plete. The project was designated to explore the
                    factors important to the design and operation of fin-
                    ancial control systems when mission and context are
                    held constant. The project investigated organizations
                    operating in the same environments, providing the same
                    services but using different management control systems
                    to determine the important factors in the design and
                    operation of control systems. In addition evaluation
                    criteria were to be refined so that control systems
                    could be judged in relation to these factors.

Title:	Cultural Implications for Teaching International Students
Investigator:	Richard A. McGonigal, Associate Professor of Administrative Sciences
Sponsor:	None
Objective:	To report to the faculty at NPS and to concerned teachers within CNET some of the more frequently encountered problems of teaching international officers within U.S. Navy classrooms.

Summary: In the past eight years a number of faculty assumptions have been identified among faculty and international students. Two surveys of students at NPS and interviews of some 30 faculty have revealed misunderstandings of both procedure and content.

It is hoped to wrap up these observations in the form of an article for Training, a CNET publication.

Title: International Management at Overseas U.S. Naval
                      Installations

Investigator: Richard A. McGonigal, Associate Professor of
                      Administrative Sciences

Sponsor: Naval Materials Procurement Command

Objective: To identify management issues which are currently
                      limiting organization effectiveness for Public Works,
                      Supply Departments and Civilian Employees Departments
                      at U.S. Navy Overseas locations.

Summary: The interface between U.S. military and host national
                      civilians at overseas bases is a field of frequent
                      conflict and non-mutually-shared assumptions.

                      The thrust of this project was to isolate those pro-
                      blems which seem to be amenable to organization de-
                      velopment interventions and to test awareness of these
                      problems on the part of commanders and U.S. senior
                      managers in whose departments these problems were
                      most common.

                      Commanding officers, executive officers, public works
                      officers, supply officers, chief civilian employee
                      officers and union representatives were interviewed
                      at Edzell and Thurso Scotland; Naples, Italy; Rota,
                      Spain; Keflavik, Iceland; Sigonella, Sicily and Subic
                      Bay, Philippines. A narrative report was prepared
                      for NMPC-6 and the overseas duty support system pro-
                      ject officer. A training package is being prepared
                      for use by said project officers.

Title: International Management of Semiconductor Assembly
                         Plants

Investigator: Richard A. McGonigal, Associate Professor of
                         Administrative Sciences

Sponsor: None

Objective: To identify and prioritize management conflicts with-
                         in the semiconductor assembly industry which are
                         culturally influenced.

Summary: This study began in July 1981. A survey was conducted
                         among 660 managers of firms having assembly plants
                         overseas to ascertain strengths and weaknesses of
                         their cross-cultural management -- particularly in
                         planning and decision making.

                         The survey identified problem areas but did not
                         succeed in indicating priorization of the impact of
                         these areas. A series of interviews is being con-
                         tinued with the assistance of local OD Network con-
                         sultants to complete the study. Target completion
                         is July 1983.

Title: Management Competencies of Heterogeneous Workgroups

Investigators: Richard A. McGonigal, Associate Professor of
                  Administrative Sciences Department and Miguel
                  Torado, Research Adjunct in Administrative
                  Sciences

Sponsor: Chief of Naval Operations

Objective: To identify those competencies of managing hetero-
                  geneous work groups which distinguish superior
                  from average managers.

Summary: Designed as a follow-on of the research done by
                  McBer and Co. in 1977 which identified sixteen
                  competencies of superior Navy managers, this study
                  focused on which of those or which additional com-
                  petencies made significant differences in managing
                  heterogeneous workgroups.

                  The basic mode of data gathering was Flanagan's
                  Critical Incident Technique. McBer and Co. trained
                  seven NPS students and 3 NPS staff in collection
                  and analysis techniques and some 433 incidents were
                  collected from 10 ships, 3 air stations and 3 squadrons.

                  The project is in the final report writing stage.
                  It has implications for LMET programs in the fleet
                  and ashore.

Title: Use of Echo Instrument in International Management

Investigator: Richard A. McGonigal, Associate Professor of
                  Administrative Sciences

Sponsor: None

Objective: To update the use of the Echo instrument as used by
                  Bechtel and others in 1968 for use among international
                  organizations to improve communication and goal clar-
                  ity.

Summary: The Echo instrument, a Q-sort variation has been used
                  by marketing analysts to approximate what is happen-
                  ing in consumer "semantic space." It is felt that
                  this technique may have useful application in inter-
                  national management not only in marketing but in goal
                  clarification.

                  The investigator used the Echo instrument in U.S.
                  headquarters of two companies which have plants over-
                  seas. Current plans include using the instrument in
                  the overseas location to identify how semantic space
                  differs within those organizations.

                  It is hoped that opportunity to complete the project
                  will be given by the end of this calendar year.

Title:	Development of ꞌ Local Area Material Distribution Plan
Investigator:	Alan W. McMasters, Associate Professor of Operations Research and Administrative Sciences
Sponsor:	Naval Supply Systems Command
Objective:	This is a continuing research effort to develop a general material distribution plan for local area support by a large wholesale activity which can then be applied to the Naval Supply Centers at Oakland, San Diego, and Norfolk.
Summary:	The Navy is in the process of implementing a recommendation of the DoD Material Distribution System (DODMDS) Study that the management and administration of wholesale supply operation of the Naval Air Stations be merged with the Naval Supply Centers (NSC) at Oakland, San Diego and Norfolk. Further, this action results in a direct support relationship between the NSCs and the local Naval Air Rework Facilities (NARF). This consolidation provides opportunity to develop a new local material distribution plan which will greatly improve supply support to all local customers of a NSC.

The procedure consists of the following four phases:

1. Material Characteristics Sensitivity Analysis
2. Material Flow Analysis
3. Stock Positioning/Material Distribution Algorithm
4. Production Support Inventories

During the past year the following progress was made: The details of the local delivery systems at NSCs Oakland and San Diego have been studied to determine the extent and form of the information available for use in an interactive vehicle scheduling algorithm. The costs of the current local delivery system at Oakland were also quantified to provide input data to an algorithm for deciding where to position an inventory in support of an industrial activity. Recommendations for improving the efficiency and reducing the second destination costs of the local delivery system at Oakland were also made.

An earlier single quarter planning horizon model for determining the quantity of a repair part to

place in a special industrial support inventory was extended to a two quarters horizon. An analysis of the benefits and computational difficulties of using this model was begun.

The probability of a given repair part being replaced during an overhaul of a TF 34-100/400 jet engine has been quantified for all such parts. That data will be a major input to the final form of the industrial support inventory.

Conference
Presentation:

A. W. McMasters and M. E. Davidson, "Three Models for Direct Delivery from a Naval Supply Center to a Naval Air Rework Facility," ORSA-TIMS Joint National Meeting, Houston, October 11-14, 1981.

Theses Directed:

D. G. Allion and J. E. Tufts, "An Analysis of Local Delivery Costs and Times at Naval Supply Center, Oakland, California," Master's Thesis, June 1982.

E. R. Slaybaugh, "A Preliminary Analysis of TF 34-100/400 Jet Engine Rework Data in Support of the MRP System Implementation at NARF Alameda," Master's Thesis, December 1981.

Title: Steam Requirements for Ships in Port

Investigator: Alan W. McMasters, Associate Professor of Operations
                     Research and Administrative Sciences

Sponsor: Civil Engineering Laboratory, Naval Construction
                     Battalion Center

Objective: To statistically analyze the steam flow rate data be-
                     ing obtained by the Port Systems Project for hotel
                     steam provided by port services to ships in port and
                     to develop a flow rate model for multiple ships.

Summary: Daily curves of steam flow rates for the various classes
                     of ships homeported in San Diego have been screened to
                     develop a "worst case" composite of observed actual
                     flow rates over the period of days during which the
                     data was obtained. In addition, worst case coordinate
                     data for three ships was obtained and subjected to
                     statistical analysis. Models of usage of port services
                     steam for a single ship and multiple ships were proposed.

Publication: Alan W. McMasters, "Steam Flow Rate Analysis for Three
                     Ships Homeported at San Diego," NPS Technical Report,
                     Forthcoming.

Title: Stock Coordination Management between NAVELEX and SPCC

Investigator: Alan W. McMasters, Associate Professor of Operations Research and Administrative Sciences

Sponsor: Naval Electronic Systems Command

Objective: This is a continuing research effort addressing the question of when inventory management of an item should be transferred from NAVELEX to SPCC.

Summary: The failure rate curves for all 2Z cog items were examined to determine when the constant rate occurs after an item is introduced into the fleet. This time interval was typically two to three years. The constant rate was assumed to correspond to the point in time when the item could be considered to be design stable. A list of all items having reached the constant rate was given to the sponsor in the spring for consideration in the stock coordination deliberations.

A study was also conducted of the current organizational level repair capabilities for electronic equipments. The study was motivated by the trend towards more corrective maintenance being performed by the organizational level in an attempt to improve surface ships' self sufficiency. Interviews of intermediate and organizational maintenance personnel were conducted at Pearl Harbor, San Diego, and Norfolk. Specific equipments of interest to the sponsor were used in these interviews to provide a frame of reference. The conclusion of the study was that given adequate training, proper tools, and increased supply support, the organizational level's repair capabilities were constrained only by the physical limitations of the ship.

Thesis Directed: N. E. Brown, "Improving the Electronic Repair Capabilities in the Fleet," Master's Thesis, March 1982.

Title: High School Graduate Information System

Investigator: Nancy A. Nieboer, Adjunct Research Professor of
                    Psychology, Department of Administrative Sciences

Sponsor: Office of the Assistant Secretary of Defense (MRA&L)
                    Directorate of Accession Policy

Objective: To begin developing an accurate and detailed information
                    system covering public, private, and parochial second-
                    ary schools, which is needed to improve Defense's high
                    school testing and recruiting programs.

Summary: During the first portion of this ongoing project, the
                    various types of necessary information were identified,
                    and the current availability and sources for the data
                    were determined. Arrangements were made to acquire
                    the latest available files from these sources. The
                    data file layout for the High School Information System
                    (HISIS) was developed and documentation for each element
                    was begun.

Conference
Presentation: Nancy A. Nieboer, "Development of a High School Infor-
                    mation System," Joint Services Selection and Classifi-
                    cation Working Group, Washington, D.C., September 14-16,
                    1982.

Title: Should Multinational Organizations Adapt Their
                    Budgeting and Control Practices to the Cultures of
                    Their Hosts?

Investigator: Solange Perret, Assistant Professor of Administrative
                    Sciences

Sponsor: NPS Foundation Research Program

Objective: To answer two interrelated questions: "Can U.S.
                    management practices be successfully exported to
                    culturally different organizations?" or "Is the
                    performance of the foreign operations related to the
                    development of new sets of practices more compatible
                    with the cultures of both the parent and the hosts?"
                    This research is part of an on-going research on cross-
                    cultural issues in management, particularly on the
                    issues created by cultural differences for the imple-
                    mentation of effective controls in multinational or-
                    ganizations. The ultimate objective is to develop a
                    model for designing effective control systems given
                    the cultural differences existing in a given organi-
                    zation.

Summary: The research could not be completed as research sites
                    could not be obtained within the time available in
                    the financial year 1981-1982. Completion is planned
                    by the Summer of 1983. The work accomplished in 1981-
                    1982 is as follows:

                    -Extensive literature search in the fields of account-
                    ing, anthropology, psychology, sociology, and manage-
                    ment.

                    -Improvement of existing instruments and identification
                    of new instruments to measure culture and budgeting be-
                    havior.

                    -Identification of improved statistical methods of
                    analysis.

Publications: S. Perret, "The Meaning of Time," in progress.

                    S. Perret, "Cross-Cultural Issues in Management,"
                    in progress.

Title:	Computer Performance Evaluation and Modeling
Investigator:	N. F. Schneidewind, Professor of Computer Science, Department of Administrative Sciences
Sponsor:	Trident Command and Control Systems Maintenance Agency, U.S. Navy
Objective:	Develop models for analyzing and predicting the performance of the IBM VM/370/CMS operating system running on IBM 3033 and 4341 hardware.
Summary:	Literature has been reviewed bearing on VM/370 models. Hypotheses and models have been formulated for predicting performance as a function of user tasks and system workload. Data has been partially collected and analyzed from the NPS IBM 3033, in order to test the model hypotheses. Work is continuing on this project.
Thesis Directed:	Waldo Marmanillo, "Performance Analysis of Computer Installations, Virtual Machine/370 (VM/370)," Master's Thesis, December 1981.

Title: Design of a Local Network for SPLICE Sites and the
                    Interface of the Local Network to the Defense Data
                    Network

Investigator: N. F. Schneidewind, Professor of Computer Science,
                    Department of Administrative Sciences

Sponsor: Fleet Material Support Office, U.S. Navy

Objective: Develop a functional design for SPLICE local area
                    networks and an interface to the Defense Data Network.

Summary: A local area network for SPLICE and an interface to
                    the Defense Data Network were designed and functional
                    specifications were written.

Publication: Norman F. Schneidewind, "Functional Design of a Local
                    Area Network for the Stock Point Logistics Integrated
                    Communications Environment," NPS Technical Report, Re-
                    port Number 54-82-003B, December 1982.

Theses Directed: Ionnis Th. Mastrocostopoulos, "Specifications of a
                    Simulation Model for a Local Area Network Design in
                    Support of Stock Point Logistics Integrated Commun-
                    ications Environment," Master's Thesis, September 1982.

                    Sharron K. Crowder and Jan M. Adams (Hopper Award),
                    "Proposal for Stock Point Logistics Integrated Commun-
                    ications Environment (SPLICE) Local Area Network Risk
                    Management," Master's Thesis, December 1982.

                    Kenneth A. Inman Jr. (Hopper Award) and Robert C.
                    Marthouse Jr., "Supply Point Logistics Integrated
                    Communications Environment (SPLICE) Local Area Computer
                    Network Design Issues for Communications," Master's
                    Thesis, June 1982.

                    Joseph N. Reinhart III and Ricardo Arana, "Database and
                    Terminal Management Functional Design Specifications in
                    Support of Stock Point Logistics Integrated Communications
                    Environment (SPLICE)," Master's Thesis, June 1982.

                    Kathlean M. Barrett, "Integration Considerations for the
                    Stock Point Logistics Integrated Communications Environ-
                    ment (SPLICE) Local Area Network," Master's Thesis,
                    December 1982.

                    Stuart Nelson, "Commercial Communication Alternatives
                    for SPLICE," Master's Thesis, December 1981.

                    Jerry D. Barnes, "Local Area Network Terminal Manage-
                    ment in Support of Stock Point Logistics Integrated
                    Communications Environment (SPLICE)," Master's Thesis,
                    December 1982.

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Craig E. Opel, "Network Management of the SPLICE
Computer Network," Master's Thesis, December 1982.

Michael L. Cooper, "Data Base Management System
Evaluation for SPLICE," Master's Thesis, December
1981.

Title: Evaluation of DoD Software Standards and Specifi-
                       cations for Use in Software Maintenance

Investigator: N. F. Schneidewind, Professor of Computer Science,
                       Department of Administrative Sciences

Sponsor: Trident Command and Control Systems Maintenance
                       Agency, U.S. Navy

Objective: Ascertain whether various DoD standards and speci-
                       fication WS 8506 and SECNAVINST 3560.1 were evalu-
                       ated with regard to their usability in software
                       maintenance.

Publications: Norman F. Schneidewind, "Software Maintenance: Im-
                       provement Through Better Development Standards and
                       Documentation," Final Report, NPS Technical Report,
                       Report Number 54-82-002, February 1982.

                       Norman F. Schneidewind, "Evaluation of SECNAVINST
                       3560.1 Tactical Digital Systems Documentation Stan-
                       dard for Software Maintenance," Final Report, NPS
                       Technical Report, Report Number 54-82-003A, February
                       1982.

                       Norman F. Schneidewind, "Evaluation of Maintain-
                       ability Enhancement for TCP/TSP Revision 6.0 Update
                       20," NPS Technical Report, Report Number 54-82-004,
                       February 1982.

                       Norman F. Schneidewind, "Usability of Military
                       Standards for the Maintenance of Embedded Computer
                       Software," in Proceedings of the North Atlantic
                       Treaty Organization Advisory Group for Aerospace
                       Research and Development, Software Avionics Symposium.
                       The Hague, Netherlands, September 1982, pp. 21-1 to
                       21-6.

                       Norman F. Schneidewind, "Usability of Military
                       Standards for the Maintenance of Embedded Computer
                       Software," NPS Technical Report, Report Number
                       54-82-005, June 1982.

Conference
Presentation: N. F. Schneidewind, "Usability of Military Standards
                       for the Maintenance of Embedded Computer Software,"
                       North Atlantic Treaty Organization Advisory Group
                       for Aerospace Research and Development Software for
                       Avionics Symposium, The Hague, Netherlands, September
                       1982.

N. R. Schneidewind, Panel: "On Maintaining Quality
Software," 6th International Conference on
Software Engineering, Tokyo, Japan, September 1982.

Title:	An Economic Model of Careerist Retention
Investigator:	George Thomas, Adjunct Professor of Economics, Department of Administrative Sciences
Sponsor:	NPS Foundation Research Program
Objective:	To develop economic models of careerist retention behavior that have predictive utility.
Summary:	Regression models were constructed to predict changes in reenlistment rates among groups of Navy ratings by using economic factors as explanatory variables. Unemployment was universally shown to be a much more important explanatory variable than pay. Results have implications for the cost-effectiveness of granting across the board pay inducements to increase military supply.
Publication:	Shu Liao and George Thomas, "Economic Factors and the Retention of Military Careerists," in progress.
Conference Presentation:	Shu Liao and George Thomas, "Retention Modeling by Occupation," Joint National Operations Research Society of America/The Institute of Management Sciences Meeting, Chicago, IL, April 1983.
Thesis Directed:	S. L. Christensen, "A Multivariate Analysis of the Determinants of Navy Enlisted Attrition," Master's Thesis, December 1982.

Title:	Feasibility of Modeling the Supply of Older Age Accessions
Investigator:	George W. Thomas, Adjunct Professor of Economics, Department of Administrative Sciences
Sponsor:	Navy Personnel Research & Development Center
Objective:	To provide an assessment of the feasibility of modeling the supply of older age accession.

Summary: At present, there are no models for the supply of
            older age enlistees. Consequently, manpower planners
            can neither accurately forecast the supply of these
            individuals nor evaluate alternative policies to
            achieve the desired level of accessions. The current
            status of supply modelling is reviewed. Particular
            attention is given to the decision context of the
            enlistment choice. The availability of data for
            conducting supply modelling is evaluated. Research
            concluded that it is feasible to model the supply of
            22-29 year-old enlistees. Ample data are available
            for supply modelling and appropriate methodologies
            can be developed for estimating a variety of models
            of the supply of older enlistees. Age-specific supply
            modelling should improve the accuracy of the younger
            age supply models.

Publication:	George Thomas, "The Feasibility of Modelling the Supply of Older Age Accessions," forthcoming
Thesis Directed:	Steve M. Kreutner, "Social, Economic and Behavioral Differences Among Enlisted Personnel Based on Age at Service Entry," Master's Thesis, October 1982.
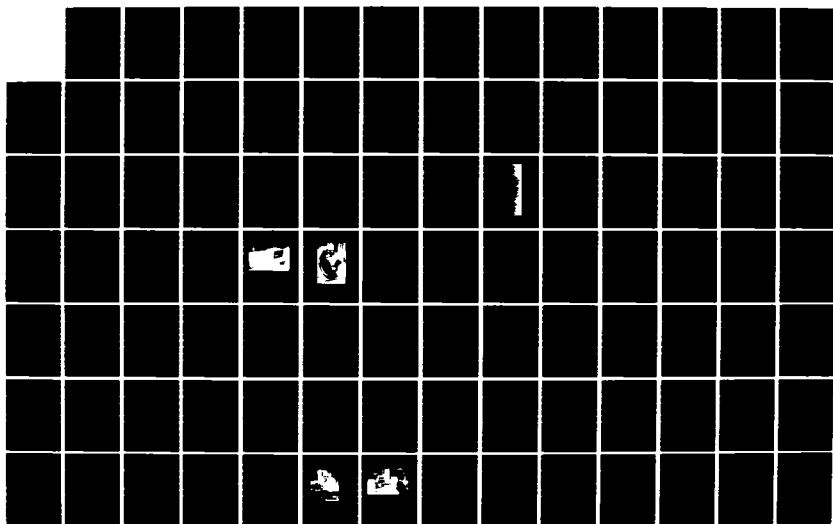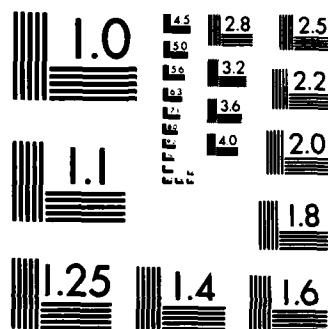
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Title: Sources and Uses of Information for Task Force and
                    Fleet Commanders

Investigators: Roger Weissinger-Baylon, Associate Professor of
                    Management Information Systems, Department of Admini-
                    strative Sciences, and Rear Admiral J. J. Ekelund,
                    Advisor

Sponsor: Naval Electronic Systems Command, C3I Systems and
                    Technology Directorate

Objective: To empirically validate the information requirements
                    for Tactical Flag Command Centers (TFCC) and Fleet
                    Command Centers (FCC) by observing Flag Officers'
                    decision making during Fleet exercises (with an em-
                    phasis on carrier group operations).

                    This project has been renewed through Fiscal Year
                    1982-1983.

Summary: For TFCC and FCC, the complete specification and em-
                    pirical validation of information requirements demands
                    an understanding of tactical decision making processes.
                    In particular, this must include decision making by
                    the OTC (Overall Tactical Commander) and his staff.
                    Otherwise, C3 specifications may impose the collection,
                    storage, and transmission of data that is inessential
                    or in highly undesirable form. Vital information,
                    which should trigger key decisions, may be excluded
                    from the system specifications or handled inexpedi-
                    tiously by TFCC/FCC. A pilot project focused on ob-
                    servation of decision making in a laboratory war game
                    involving carrier group operations in an ASW context.
                    The observational and analytical techniques that were
                    developed are now being applied to study actual OTC
                    decision making (aboard the USS Enterprise with RADM
                    Barth, and at the Naval War College with RADM Aitcheson
                    and RADM Gureck. The research will develop testable,
                    empirically based specifications of C3 information
                    sources and uses; the resulting improvement to TCFF/
                    FCC will provide a valuable force multiplier for
                    vital weapon platforms and personnel, and new theo-
                    retical frameworks for the understanding of Naval
                    decision making.

                    The project team benefited from meetings with VADM
                    Fowler, VADM Nagler, VADM Travers, VADM Waters, RADM
                    Ekelund, RADM Kollmorgen, RADM Moore, and COMO Simon.
                    Moreover, ADM Thomas Hayward (CNO, retired), ADM Alfred
                    Whittle (CNM, retired), ADM Worth Bagley (Vice CNO re-
                    tired), and ADM Elmo Zumwalt (CNO, retired) have visited

the Naval Postgraduate School to contribute to this project. As a result of meetings with ADM Small (Vice CNO) and General David Jones, Chairman of the Joint Chiefs of staff, the research focus has been extended, including an added emphasis on joint exercises.

Publications: Roger Weissinger-Baylon, "Cognitive Analysis of Communication Errors: A New Implementation and Evaluation Approach for Decision Support," in Proceedings of the Conference on Decision Support Systems: DSS-81, June 1981.

Roger Weissinger-Baylon, "Communications as Loose Couplings in Naval Force Organizations," Management Science, forthcoming.

Roger Weissinger-Baylon, "A Non-rational Perspective on the Implementation of Decision Support Systems," Communications of the ACM, forthcoming.

Roger Weissinger-Baylon, (with Hackathorn, R. Keen, P. G. W., and Konsynski, B.), "The Representation of Managerial Tasks in Decision Support Systems," IEEE Computer, forthcoming.

Roger Weissinger-Baylon, (with ADM Worth Bagly), "A Commander's Control over Force Command and Control," Proceedings of the Naval Institute, forthcoming.

Conference
Presentation: Roger Weissinger-Baylon, "Representation Issues in Decision Support for C3," Colorado Workshop on Representation, October 1981.

Roger Weissinger-Baylon, "Representation of Managerial Tasks in Decision Support Systems," Maui Workshop on Representation, Maui, Hawaii, January 1982.

Roger Weissinger-Baylon, (with ADM Elmo Zumwalt, ADM Worth Bagley, CAPT Wayne Hughes), "C3 Issues in the Falklands War," Seminar Series at the Naval Postgraduate School, Monterey, CA, June 1982.

Thesis Directed: H. E. Allen and D. E. Rannels, "Examination of Battle Group Commander Decision Processes and Support Information," Master's Thesis, June 1982.

Title: Prediction of College Acheivement from the Scholastic
                    Aptitude Test and the High School Record

Investigator: R. A. Weitzman, Associate Professor, Department of
                    Administrative Sciences

Sponsor:·   None

Objective: To investigate and correct the low observed predictive
                    validity of the SAT

Summary: The study shows the SAT predictive validity to be low
                    because of criterion scale multiplicity: A grade in
                    one college does not represent the same achievement
                    as the same grade in another. The study also derives
                    a method for correcting validities for this problem
                    and applies it to the SAT.

Title: Sequential Testing for Selection

Investigator: R. A. Weitzman, Associate Professor, Department of
                  Administrative Sciences

Sponsor: NPS Foundation Research Program/Chief of Naval Research

Objective: To develop and try out method of testing one item at
                  a time to determine accept or reject selection decisions
                  with preset error probabilities.

Summary: On both Monte Carlo and real data, the observed error
                  rates closely matched the preset error rates. The
                  method used involved an approximation of a Waldian
                  probability-ratio test applied to the evaluation of
                  composite, rather than point, hypotheses. Mean test
                  lengths ranged from 5 to 47, depending on the preset
                  error rates.

Title: Test Bias and Validity

Investigator: R. A. Weitzman, Associate Professor, Department of
                 Administrative Sciences

Sponsor: None

Objective: To define and determine the effect of test bias on the
                 predictive validity of a selection test.

Summary: A formula for score adjustment was developed to correct
                 test bias as measured by the partial correlation be-
                 tween test score and race controlling for the criterion.
                 For the SAT, the adjustment amounted to an increase of
                 black scores by almost 100 points.

Publication: R. A. Weitzman, "Test Bias and Validity," Psychological
                 Bulletin, forthcoming.

Title: Training Systems Cost/Effectiveness Study

Investigators: R. A. Weitzman, Associate Professor, Department of
                    Administrative Sciences, F. C. Horton, Associate
                    Professor, Department of Administrative Sciences, T.
                    G. Sticht, Adjunct Professor, Department of Admini-
                    strative Sciences, and J. L. Zatkin, Research Assist-
                    ant, Department of Administrative Sciences

Sponsor: Naval Air Systems Command

Objectives: (1) To evaluate existing and recommend new procedures
                    for estimating the cost and the effectiveness of dif-
                    ferent training media.
                    (2) To study and to recommend methods for streamlin-
                    ing the Instructional Systems Development process re-
                    quired for contractors who develop new training pro-
                    grams.

Summary: Professor Horton and I have recommended empirical est-
                    imation procedures. I have presented experimental and
                    nonexperimental alternatives: the experimental to com-
                    pare different instructional media for P-3 Acoustic
                    Analysts at Moffett Field, the nonexperimental to com-
                    pare different instructional media for P-3 (Moffett
                    Field) and S-3 (North Island) tactical officers. Dr.
                    Sticht, Ms. Zatkin, and I have prepared a report of
                    over 50 pages describing our study and presenting our
                    recommendations for streamlining the ISD process.

Publication: R. A. Weitzman, F. C. Horton, T. G. Sticht and J. L.
                    Zatkin, "Instructional Systems Development in the
                    Navy: A Discussion of Concepts and Issues," NPS Pro-
                    ject Report, NPS54-82-010PR, September 1982.

Title: Use of Sequential Testing to Pre-Screen Prospective
                     Recruits for Military Service

Investigator: R. A. Weitzman, Associate Professor, Department of
                     Administrative Sciences

Sponsor: Navy Personnel Research and Development Center

Objective: Sequential testing for selection requires an applicant
                     to respond to one item at a time till an acceptance
                     or rejection decision occurs with prespecified proba-
                     bilities of error. The method depends on the existence
                     of a bank of calibrated items. The purposes of this
                     study are to calibrate every item in the bank developed
                     by NPRDC to pre-screen recruits and to simulate the
                     sequential-testing method on the data used for the
                     item calibration.

Summary: The bank to be calibrated consists of 200 items. For
                     the method to work, the correlation between any pair
                     of these items must be due solely to the correlation
                     of each with the criterion to be predicted, in this
                     case AFQT score. The study compared three methods
                     of item selection, one of which involved the partial
                     correlation between a candidate item and each already
                     selected item, with the AFQT partialled out. This
                     method was the poorest of the three; it resulted in
                     the tests of greatest mean length and largest mismatches
                     between nominal and observed error rates. The best
                     method selected items simply in the order of their
                     zero-order correlations with the AFQT.

Publication: R. A. Weitzman, "Use of Sequential Testing to Pre-
                     Screen Prospective Recruits for Military Service," in
                     Proceedings of the 1982 Biennial ONR CAT/IRT Conference,
                     forthcoming.

Conference
Presentation: R. A. Weitzman, "Use of Sequential Testing to Pre-
                     Screen Prospective Recruits for Military Service,"
                     Biennial ONR CAT/IRT Conference, Minneapolis, MN,
                     July 1982.

Title: Support of the Defense Productivity Program Office
                    and Projects (1982-1983)

Investigators: David Whipple, Associate Professor of Administrative
                    Sciences Department, Jack LaPatra, Adjunct Professor
                    of Administrative Sciences Department, Philip Bromiley,
                    Assistant Professor of Administrative Sciences De-
                    partment, and Commander Peter Blondin, Instructor of
                    Administrative Sciences Department

Sponsor: Office of the Assistant Secretary of Defense

Objective: During FY 82 to assess the effectiveness, efficiency,
                    and appropriateness of the Defense Productivity Program
                    Office (DPPO) and the programmatic content of its
                    activities.

                    During FY 83 to assist in the restructuring of DPPO's
                    programs and internal organizations in accordance with
                    the recommendations derived in the 1982 portion of our
                    effort, and to begin a continuing program of research
                    in productivity enhancement to support DPPO and CPP
                    needs.

Summary: Utilizing an analytical model developed during our
                    1981 NPS Foundation research on intra-organizational
                    behavior, we assessed the internal consistency and
                    goal congruence of the activities and programmatic
                    structure of DPPO with both the stated purpose for
                    its establishment (as contained in DoD Directive 5010.31)
                    and the needs of other interested individuals and
                    organizations dependent in various ways on the pro-
                    ductivity enhancing efforts of DPPO. The conclusions
                    and recommendations were briefed to Mr. Jerry Calhoun,
                    the Deputy Assistant Secretary of CPP, who accepted
                    them and asked us to continue both our consultive and
                    research support. We have agreed on expecting the re-
                    lationship to extend into the foreseeable future. A
                    number of scholarly publications are planned, the ini-
                    tial being an analysis of the inadequacies of present
                    DoD productivity measures.

Title: U.S. Coal Resources and Defense Strategy: A Prelimi-
                    nary Investigation (1981-82)

Investigators: David Whipple, Associate Professor of Administrative
                    Sciences Department, Dan Boger, Assistant Professor
                    of Administrative Sciences Department, Jack LaPatra,
                    Adjunct Professor of Administrative Sciences Depart-
                    ment

Sponser: NPS Foundation Research Program

Objective: The overall objectives of this portion of this long
                    term research project are: to model the present market
                    structure of the U.S. coal industry; to identify the
                    major relationships and possible scenarios which will
                    affect the long term equilibrium demand for coal from
                    U.S. sources; to estimate/forecast long term (2000)
                    coal prices and production levels based on identifiable
                    domestic and export demand; to estimate the role which
                    U.S. coal supplies could play in fulfilling the long
                    term energy needs of South Korea; to derive market-
                    based federal policy initiatives which could facilitate
                    the increasing dependence of Korea on U.S. coal; and to
                    attempt some initial extrapolations to policies which
                    would increase other such allied nation dependence.

Summary: The United States is rich in coal resources. However,
                    in the past these coal resources have been of only
                    marginal interest because of the relative availability
                    and economy associated with petroleum and natural gas.
                    When the Organization of Petroleum Exporting Countries
                    (OPEC) acted to dramatically increase the price of oil
                    and to demonstrate that its availability was subject to
                    significant non-market manipulation, coal became a much
                    more attractive energy source from both an economic and
                    a political point of view. In particular, since the
                    Oil Embargo the United States has become painfully
                    aware of the extent to which the dependence of allied
                    nations on foreign sources of energy resources can
                    impinge upon the degree of international allied commit-
                    ment to support U.S. diplomatic and defense efforts.
                    The hypothesis underlying the present proposal is that
                    a judicious policy of relatively passive support for the
                    development of the U.S. coal resource and the adoption
                    of an aggressive international marketing strategy for
                    coal may lead over time to a substitution of both
                    domestic and allied nation energy market reliance on
                    the U.S. and thus may foster a stronger overall defense
                    posture.

We have been fortunate enough to obtain a data base
for the U.S. coal supply and demand sectors which is
suited to analysis of this possibility. Its charac-
teristics include estimation of the quantity of coal
resources by U.S. supply region and various geologi:
parameters as well as forecasts of the cost mining n
the year 2000 time period. We are continuing our
efforts to estimate the possibility of substitutin
U.S. coal for present exogenous energy sources in :he
long term future of South Korea, given its energy
plans, present and forecast supply sources, and the
range of possible export prices for the various
U.S. coals in the year 2000. The assessment of the
Korean energy future is complete (see Mr. Cha's
thesis listed in the Thesis section below).

We expect to submit a technical paper to the
Journal of Energy and Development and a policy paper
to the _Journal of Public Policy Analysis and_
Management in the Spring.

Thesis Directed: Jin Seob Cha, "An Assessment of the Role of Coal in
the Long-Term Energy Plan for Korea," _Master's_
Thesis, March 1982.

DEPARTMENT

OF

OPERATIONS RESEARCH

DEPARTMENT OF OPERATIONS RESEARCH

Operations Research (OR) is a multi-disciplinary field, a fact which is reflected by the variety of areas covered by the sponsored research of the faculty. The topics can be grouped into broad areas of basic research in the techniques of OR and its applications to military problems. The techniques are mathematical programming and stochastic processes. The applications areas include combat models, manpower and personnel, supply and logistics, tactical analysis, and command, control and communication.

MATHEMATICAL PROGRAMMING

Continuing research by Professor Brown of Operations Research and Professor Bradley of Computer Science, sponsored by the Office of Naval Research (ONR), is leading to further development of extremely fast mathematical programming codes which exploit the special structure of certain network optimization problems. The work is extremely important in material distribution applications. As a result of this research program, the Naval Postgraduate School continues to have one of the most powerful existing optimization laboratories.

STOCHASTIC MODELING/STATISTICS

Professor Gaver, under ONR funding, continues development of stochastic models for communications systems, computer systems, systems involving maintenance and repair, and environmental prediction.

Professors Jacobs and Lewis continue to derive properties for new stochastic point processes and time series models. In addition, new methods for simulating a broad class of stochastic point processes have been discovered. Applications of these processes to oceanographic phenomena are being pursued. This work is supported by ONR and the National Science Foundation. Professor Lewis also continues work in simulation analysis, particularly development of a revision to the LLRANDOM generator.

Professor Esary has continued his studies in reliability. Professor Larson and Professor Jayachandran of Mathematics have continued analysis of spectrometric data from oil analysis under sponsorship of the DOD. Professors Read and Tysver have continued work on torpedo tracking programs for the Naval Undersea Warfare Engineering Station.

COMBAT MODELS

Professors Parry and Hartman continue to develop a computer simulation model of air/land combat for the U.S. Army Training and Doctrine Command. This model is now being used for studies supporting current decisions. Professor Taylor has continued his studies of warfare via Lanchester-type differential equations. This work is supported by ONR and the Army Research Office. A text on Lanchester's Equations is completed with publication expected in 1983.

TACTICAL ANALYSIS

The tactical analysis division of ONR funded the start of a long-term project led by Professor Washburn. Professors Shudde and Forrest concluded this year an evaluation of alternative programmable calculators to replace the HP67/97 in air ASW operations. Professor Washburn initiated research in mine warfare with results in countered minefield planning. Professor Andrus is evaluating the capabilities of micro computers for wargaming analysis, and continues his evaluation of contractor support for the tactical analysis program of the Commanders of Naval Air Pacific and Atlantic.

Professor Forrest continues to direct the Strategic Systems Project Office research program at the Naval Postgraduate School. In addition, he has produced additional programmable calculator models for magnetic anomaly detection.

MANPOWER AND PERSONNEL

Professor Milch continues to develop interactive models of the Naval officer system for policy analysis and manpower/personnel planning. This is a cooperative research project between the Operations Research and Administrative Science departments.

VOICE INPUT TO COMPUTERS

Professor Poock continues his work in adapting available hardware to perform voice input of data to computers, with applications in Command, Control and Communication. This work is sponsored by the Naval Electronics Systems Command.

LOGISTICS AND SUPPLY

Professors Richards, McMasters and Howard have initiated research into wholesale provisioning models for new weapons systems, sponsored by Naval Fleet Material Support Office. Professor McMasters continued his research, sponsored by Naval Supply Systems Command, into material distribution systems for local area support by large wholesale activities.

Title: Evaluation of ONR Contractor COMNAVAIRPAC and
                    COMNAVAIRLANT TAC D&E Program

Investigator: A. F. Andrus, Associate Professor of Operations
                    Research and Statistics

Sponsor: Office of Naval Research

Objective: Evaluate FY-81 Contractor Support program in TAC D&E
                    for ONR, Code 230. Evaluation to involve review and
                    evaluation of contract deliverables; review and
                    evaluation of contract task requirements; evaluation
                    of program direction and accomplishments.

Summary: A total review and evaluation of the FY81 program was
                    completed. The evaluation report included:

                    a) Identification of contract requirements.

                    b) Comparison of requirements and objectives.

                    c) Determination of accomplishments.

                    d) Quality of results.

                    e) Utility of results.

                    f) Recommended improvements.

                    g) Problem of relating cost in improvements.

Publication: A. F. Andrus, "Review of 1981 ONR Contractor Support
                    Air TAC D&E Program," ONR Technical Report, Code 230,
                    27 April 1982.

Title:	Microcomputer Simulation Capabilities-Interactive Graphics
Investigator:	A. F. Andrus, Associate Professor of Operations Research and Statistics
Sponsor:	Office of Naval Research
Objective:	Explore capabilities of standard microcomputer for wargaming analysis and Interactive Gaming/Graphics
Summary:	Two APPLE III systems were purchased and used by students under direction of A. F. Andrus. Models were developed for Interactive Graphics/Tactical Analysis and Interactive Gaming.
Theses Directed:	J. McCorkle, "Tactical Motion Analyses," Master's Thesis, September 1982.
	C. Owens, "TEMPO: An Interactive Simulation for the APPLE III," Master's Thesis, September 1982.
	J. Wilson, "An Interactive Model of the Air Battle Analyses for the APPLE III," Master's Thesis, September 1982.

Title: TAC D&E Technical Administration

Investigator: A. F. Andrus, Associate Professor of Operations
Research and Statistics

Sponsor: Office of Naval Research

Objective: Technically administer and monitor ONR TAC D&E
program for COMNAVAIRPAC.

Summary: During Quarter 4 my efforts were redirected to
assume Scientific Officer technical responsi-
bility for the TAC D&E program for COMNAVAIRPAC.
This included:

a) writing requests for proposals;

b) evaluating contractor proposals;

c) technically monitoring and evaluating current
projects.

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Title: Large-Scale Nonlinear/Integer Optimization Project

Investigators: Gerald G. Brown, Professor of Operations Research, Glenn W. Graves, Professor of Management Science and Mathematics, University of California, Los Angeles

Sponsor: U. S. Air Force

Objective: To develop new theory and methods for nonlinear optimization applied to procurement of nonnuclear munitions.

Summary: A tactical sortie allocation model was built for theater level evaluation of nonnuclear munitions procurement options. A new optimization system was developed, installed and used to solve large nonlinear optimization models arising within the sortie allocations. Enhancements were developed to consider weather conditions, logistical lead time to deploy, and other real-life considerations. The system is now used by theater evaluation teams to rationalize annual procurements in excess of 1.5 billion dollars. This is the first system of such complexity known to be used in a real-time computing environment, providing users with immediate responses to critical inquiries.

Thesis Directed: P. Lord, "An Examination of the United States Air Force Optimal Nonnuclear Munitions Procurement Model," Master's Thesis, October 1982.

Title:	Large-Scale Optimization
Investigators:	Gerald G. Brown, Professor of Operations Research, Gordon H. Bradley, Professor of Computer Science
Sponsor:	Office of Naval Research
Objective:	Develop theory and algorithms for solution of large-scale optimization models.

Summary:

The Naval Postgraduate School research program in large-scale optimization has continued with progress on several fronts. Optimization of generalized networks, networks with gains, fixed charge networks, and imbedded networks, has received further attention. Such models can now be solved nearly as efficiently as pure networks. Large-scale nonlinear and mixed integer models can now be solved in real time, with model generation facilities and report extraction tools permitting rapid response to analyst queries. New decomposition and relaxation methods for very large models have yielded extremely efficient solutions of complex mixed integer problems. More important, new theoretical insight has been gained in the convergence properties of these approaches which helps explain our success, and two decades of failure by other researchers.

Awards:

G. G. Brown and G. Graves, 1981 International Management Science Achievement Award, Honorable Mention.

G. G. Brown, Sigma Xi Research Award, Naval Postgraduate School, 1982.

Publications:

G. G. Brown and B. O. Shubert, "On Random Binary Trees," Mathematics of Operations Research, forthcoming.

J. G. Taylor and G. G. Brown, "Annihilation Prediction for Lanchester-Type Models of Modern Warfare," Operations Research, forthcoming.

G. G. Brown and G. Graves, "Real-Time Dispatch of Petroleum Tank Trucks," Interfaces, forthcoming.

G. G. Brown and W. Wright, "Automatic Identification of Embedded Network Rows in Large-Scale Optimization Models," Mathematical Programming, forthcoming.

G. H. Bradley, G. G. Brown and G. Graves, "Structural Redundancy in Large-Scale Optimization Models," in Redundancy in Mathematical Programming, Springer Verlag, December 1982, forthcoming.

R. Goren, D. Bausch and G. Brown, "Determination of Optimal Aircraft Mix in an Air Force," NPS Technical Report, NPS55-81-025, December 1981.

G. Brown, G. Bradley and G. Graves, "Review of the Computational Aspects of the TBS Regulatory Analysis Financial Model," Electric Power Research Institute Technical Report, September 1981.

G. Brown, G. Graves and M. Honczarenko, "Large-Scale Facility and Equipment Location: An Application of Goal Programming in Multicommodity Decomposition," Technical Report, University of California, Los Angeles, September 1981, 24 pages.

G. Brown and R. McBride, "Extracting Embedded Generalized Network Problems from General LP Problems," Technical Report, School of Business, University of Southern California, September 1981, 11 pages.

G. Brown and R. McBride, "Efficient Solution of Generalized Network Problems," Technical Report, School of Business, University of Southern California, September 1981, 34 pages.

G. Brown and W. Wright, "Automatic Identification of Embedded Structure in Large-Scale Optimization Models," appears in Large-Scale Linear Programming, G. Dantzig, M. Dempster and M. Kallio, eds., International Institute for Applied Systems Analysis, Laxenburg, Austria, 1981, pp. 781-808.

G. Brown and D. Thomen, "Automatic Identification of Generalized Upper Bounds in Large-Scale Optimization Models," appears in Large-Scale Linear Programming, G. Dantzig, M. Dempster and M. Kallio, eds., International Institute for Applied Systems Analysis, Laxenburg, Austria, 1981, pp. 747-780.

Conference Presentations:

G. Brown and G. Graves, "Real Time Dispatch of Petroleum Tank Trucks," International Management Science Achievement Award Competition, Detroit, 18 April 1982.

G. Brown, R. Duff and M. Finley, "Design and Demonstration of a Microcomputer-Based Network Optimization System," ORSA/TIMS National Meeting, Detroit, April 1982.

G. Brown and R. McBride, "Efficient Solution of Generalized Networks, ORSA/TIMS National Meeting, Detroit, 20 April 1982.

G. Brown, V. Bain and A. Toprak, "A Case Study in
Facility and Equipment Planning: Crash Projects
(and Modeling) Can Work," ORSA/TIMS National Meeting,
Detroit, 21 April 1982.

G. Brown and G. Graves, "Application of a New Class
of Decompositions to Problems of Production, Inventory
and Distribution," International Mathematical Program-
ming Society, Bonn, W. Germany, 26 August 1982.

G. Brown, G. Graves and R. McBride, "User Friendly
Tools for Interactive Optimization," ORSA/TIMS National
Conference, San Diego, 25 October 1982.

G. Bradley, G. Brown and A. Geoffrion, "Mathematical
Programming Models for Multiperiod Production and
Sales Planning," ORSA/TIMS National Conference, San
Diego, 25 October 1982.

Theses Directed: M. Finley, "An Extended Microcomputer-Based Network
Optimization Package," Master's Thesis, October 1982.

D. Bausch, "Computational Advances in the Solution
of Large-Scale Set Covering and Set Partitioning
Problems," Master's Thesis, October 1982.

P. Lord, "An Examination of the United States Air
Force Optimal Nonnuclear Munitions Procurement Model,"
Master's Thesis, October 1982.

Title: Reliability Studies

Investigator: J. D. Esary, Professor of Operations Research and
                    Statistics

Sponsor: Naval Undersea Warfare Engineering Station (NUWES)

Objective: To conduct a series of exploratory seminars on the
                    potential applications of reliability analysis to
                    range support systems.

Summary: A sequence of seminars on methods of reliability
                    analysis of potential interest in the design and
                    procurement of range support systems was conducted
                    at NUWES during November of 1981. The goal of the
                    program was to develop some specific analytical
                    tasks. During the course of the visit an opportunity
                    arose to compute a performance characteristic for the
                    System Acceptance Test included in the Specification
                    of Overhaul of the TROV-N underwater recovery vehicle.
                    The analysis and some tables were communicated in
                    hand-printed form prior to departure from NUWES.

Title: FBM Vulnerability and Effectiveness Research

Investigator: R. N. Forrest, Professor of Operations Research and
                Chairman ASW Academic Group

Sponsor: Strategic Systems Project Office

Objective: To analyze FBM vulnerability and effectiveness.

Summary: The relative effectiveness of two motion strategies
                was analyzed.

Publications: R. N. Forrest, "Two Motion Strategies," NPS Project
                Report, NPS71-82-001PR, December 1982.

Title: Target Motion Analysis

Investigator: .   R. N. Forrest, Professor of Operations Research and
                        Chairman ASW Academic Group

Sponsor: NPS Foundation Research Program

Objective: To develop a single leg bearings-only target motion
                        analysis procedure.

Summary: A procedure was developed and is described in the
                        publication listed below.

Publications: R. N. Forrest, "A Target Motion Analysis Procedure,"
                        NPS Technical Report, NPS71-81-003, October 1981.

Title:	Computational Statistical Tools for Weather Forecasting
Investigator:	D. P. Gaver, Professor of Operations Research and Statistics
Sponsor:	Naval Environmental Prediction Research Facility
Objective:	To develop computational-statistical methodology for use in analysis of weather data and for forecasting of weather conditions.
Summary:	Extensive exploratory computations were made to develop numerical single-station forecasts for low stratus at airports; data from Moffett Field, California, was examined by means of logistic regression models.
Publication:	D. P. Gaver, "Low-Level Stratus Prediction Using Binary Statistical Regression: A Progress Report," forthcoming.

Title: Stochastic Modeling and Data Analysis

Investigators: D. P. Gaver, Professor of Operations Research and
                          Statistics
                          P. A. Jacobs, Associate Professor of Operations
                          Research
                          J. P. Lehoczky, Professor of Statistics, Carnegie-
                          Mellon University
                          G. Latouche, Professor of Computer Science, Free
                          University of Brussels

Sponsor: Office of Naval Research

Objective: To develop and show how to apply statistical methods
                          of data analysis and probability modeling to prob-
                          lems arising in the environment (weather, meteoro-
                          logy), communications, computer systems, military
                          C^3 and equipment reliability.

Summary: Investigations were conducted, and reports given on
                          these topics:

                          a) Statistical summarization and modeling of Arctic
                              subsurface in ice roughness,

                          b) The superposition of random loads on structures,

                          c) The availability of failure-prone inspected
                              standby equipment,

                          d) Models for delays to processor-sharing computer
                              systems,

                          e) Use of interactive Markov chain models in man-
                              power planning,

                          f) Models for maintained system reliability and
                              availability in "random environments,"

                          g) Simple compact formulas for percent point of
                              student's t (and other distributions of
                              statistical importance),

                          h) Stochastic control of economic processes.

Publications: D. P. Gaver and J. P. Lehoczky, "Channels that
                          Cooperatively Service a Data Stream and Voice Messages,"
                          IEEE Transactions on Communications, Vol. COM-30, No. 5,
                          pp. 1153-1161, 1982.

                          D. P. Gaver and R. G. Miller, Jackknifing the Kaplan-
                          Meier Survival Estimator for Censored Data," Communi-
                          cations in Statistics, A, forthcoming.

Publications:
D. P. Gaver and P. A. Jacobs, "Data Analysis and Modeling of Arctic Sea Ice Subsurface Roughness; A Summary," Proceedings of ONR Workshop Signal Processing in the Ocean Environment, Annapolis, May, 1982.

Title:	Probabilistic Models for Complex Systems
Investigator:	P. A. Jacobs, Associate Professor of Operations Research
Sponsor:	National Science Foundation
Objective:	Develop and study stochastic models for complex systems. This research is the final phase in this study.
Summary:	Among the stochastic models considered during this reporting period were the following 1) discrete time series models, 2) models for systems whose environment is subject to randomly occurring fluctuation, for example from weather, which result in changes in the parameters of the model, 3) models for the flow of individuals through a hierarchical organization.
Publications:	D. P. Gaver, P. A. Jacobs and G. Latouche, "Finite Birth-and-Death Models in Randomly Changing Environments," NPS Technical Report, NPS55-82-007, February 1982. Revision to appear in Journal of Applied Probability.
	G. Latouche, D. P. Gaver and P. A. Jacobs, "Finite Markov Chain Models Skip-free in One Direction," NPS Technical Report, NPS55-82-015, April 1982.
	P. A. Jacobs and P. A. W. Lewis, "Stationary Discrete Autoregressive-Moving Average Time Series Generated by Mixtures," NPS Technical Report, NPS55-82-003, January 1982. Revision to appear in Journal of Time Series Analysis.
	J. P. Lehoczky, P. A. Jacobs and D. P. Gaver, "Interacting Markov Chain Models for Manpower Systems," NPS Technical Report, NPS55-82-018, July 1982.
Conference Presentations:	P. A. Jacobs, "An Exploratory Analysis of Oxidant Data and Meteorological Variables of the San Francisco Area," Seventh Conference on Probability and Statistics in Atmospheric Sciences of the American Meteorological Society, Monterey, November 1981.
	P. A. Jacobs and P. A. W. Lewis, "Stationary Discrete Autoregressive-Moving Average Time Series Generated by Mixtures," Western Regional Meeting of the Institute of Mathematical Statistics, San Diego, June 1982.

Title:	Some Statistical Problems in Applied Probability
Investigator:	P. A. Jacobs, Associate Professor of Operations Research
Sponsor:	NPS Foundation Research Program
Objective:	To investigate and model a profile of sea ice cover in the Southern Beaufort Sea that was obtained by the submarine USS GURNARD in April 1976 using a narrow beam upward-looking sonar.

| Summary: | Arctic Sea ice behavior, particularly roughness and ridging patterns above and below the surface of the ocean is of scientific interest to oceanographers and geologists. It is also of potential interest to those conducting military operations in the Arctic, and to those exploring for petroleum and other minerals. This pilot study investigated the distribution of the depths of keels (large protuberances of ice beneath the sea surface) and of the distances between relatively deep keels. The data suggest that an exponential-<u>like</u> but not precisely exponential model may well represent the data: the simple exponential model tends to underestimate the distances between keels and the extreme keel depths. The methods utilized are those of exploratory data analysis and of fitting "sculptured exponential" distributions. |

| Publication: | D. P. Gaver and P. A. Jacobs, "Data Analysis and Modeling of Arctic Sea Ice Subsurface Roughness--A Summary," <u>Signal Processing in the Ocean Environment</u>, forthcoming. |
| Conference Presentation: | D. P. Gaver and P. A. Jacobs, "Data Analysis and Modeling of Arctic Sea Ice Subsurface Roughness," ONR Workshop on Signal Processing in the Ocean Environment, Annapolis, May 1982. |

Title: Analysis of Eddy Current and Ultrasonic
                    Nondestructive Inspection Data

Investigators: Harold J. Larson, Professor of Operations Research
                    and Statistics, Toke Jayachandran, Associate
                    Professor of Mathematics

Sponsor: Kelly Air Force Base

Objective: Analyze nondestructive inspection data, develop
                    scoring system for periodic testing of technician
                    capability.

Summary: During 1981 a nondestructive inspection technician
                    proficiency test was run using specially constructed
                    plates with known flows of known sizes. This data
                    has been used to develop a method of scoring tech-
                    nician proficiencies, incorporating the use of
                    different size flows.

Publication: H. J. Larson and T. Jayachandran, "Analysis of Eddy
                    Current and Ultrasonic Nondestructive Inspection
                    Data," forthcoming.

Title:	OAP Routines for CEMS IV
Investigators:	Harold J. Larson, Professor of Operations Research and Statistics, Toke Jayachandran, Associate Professor of Mathematics
Sponsor:	Kelly Air Force Base
Objective:	Develop computerized routine for OAP recommendations incorporating records of oil additions.

Summary:

The Air Force oil analysis data base is to be included in the larger data base of CEMS IV and all Air Force oil analysis labs will have computer terminals. We provided the CEMS IV prototype contractor with a flow chart, and all necessary formulas, to allow the computer to give the oil analysis technician real time recommendations, incorporating any oil-addition data available. We also analyzed previously gathered data on ferrography, estimating the variability of repeated readings, as well as from one slide to another or one lab to another.

Publications:

H. J. Larson and T. Jayachandran, "Statistical Methods for the Joint Oil Analysis Program," NPS Technical Report, NPS55-82-002, January 1982.

H. J. Larson and T. Jayachandran, "OAP Routines for CEMS IV," forthcoming.

Title: Dual Screen Interactive Time Series Facility

Investigator: P. A. W. Lewis, Professor of Operations Research and
                   Statistics

Sponsor: NPS Foundation Research Program

Objective: To get GRAFSTAT2 running on the NPS computing facility,
                   examine its utility for handling large data sets in our
                   computing environment and subsequently implement applica-
                   tions packages in GRAFSTAT2 for time series analysis,
                   multiple time series analysis and point process analysis.

Summary: A first version of the experimental IBM APL program
                   GRAFSTAT2 was installed on a test-bed basis at the Naval
                   Postgraduate School in January of 1982 and an updated
                   version in October 1982. A greatly enhanced version
                   GRAFSTAT3 is expected in February 1983, incorporating
                   suggestions from our experience with the package. On our
                   side, with the help of L. Uribe, we have developed an APL
                   workspace called TSERIES containing most of the common
                   time series routines.

                   With GRAFSTAT2 and TSERIES we were able to do in four hours
                   an analysis of wind speed data from Ship PAPA. The same
                   analysis took a Ph.D. student (D. K. Hugus) six months to
                   do on the batch facility with the Versatec plotter. This
                   time series facility is now being used to analyze ten years
                   of temperature data from Big Sur (in conjunction with
                   Oceanography Ph.D. student, L. Breaker) and to analyze
                   profiles of sea temperature and salinity data taken by
                   the Oceanography Department.

Publication: P. A. W. Lewis, "An APL Workspace HOWTSERIES," NPS Technical
                   Report, forthcoming.

Title:	Stochastic Analysis and Simulation
Investigator:	P. A. W. Lewis, Professor of Operations Research and Statistics
Sponsor:	Office of Naval Research

Objective: The purpose of this research is to develop models for the analysis of stochastic point processes and time series, develop new statistical methodology for use in the simulations which are required in mathematical statistics and in the analysis of stochastic systems, and to pursue stochastic modelling and data analysis for stochastic systems such as the Circadian sleep-wake process in mammals. This is a continuing program.

Summary:

1. A structure in exponential variables which subsumes all previous work on exponential processes and gives second and third-order exponential autoregressive processes was delineated.

2. The exponential time series work was applied to the delineation of simple multivariate exponential random variables.

3. Work on the new Gamma time series model (GLARMA(p,q)) and solution of the problem of obtaining maximum likelihood estimates in the first-order case was completed.

4. Analysis of 15 years of wind velocity data from Ship PAPA and modelling of this data with a non-stationary version of the Gamma model was completed.

5. A method for doing residual analysis for non-normal time series with autoregressive correlation structure was discovered.

6. A method for doing quantile estimation for systems simulation with dependent data was worked out.

Publications:

P. A. W. Lewis and P. Heidelberger, "Quantile Estimation for Dependent Sequences," Operations Research, forthcoming.

P. A. W. Lewis and A. J. Lawrance, "Generation of Some First-Order Autoregressive Sequences of Positive Random Variables with Given Marginal Distributions," in Proceedings Applied Probability/Computer Science Conference, R. Disney, ed., forthcoming.

P. A. W. Lewis and A. J. Lawrance, "Simple Dependent Pairs of Exponential and Uniform Random Variables," Operations Research, forthcoming.

P. A. W. Lewis and P. A. Jacobs, "Stationary Discrete Auto-Regressive-Moving Average Time Series Generated by Mixtures," Journal of Time Series Analysis, forthcoming.

Publications: P. A. W. Lewis and D. K. Hugus, "A New Gamma Process with Mixed Autoregressive-Moving Average Correlation Structure," in progress.

P. A. W. Lewis and D. K. Hugus, "An Analysis of Wind Velocity Data from Ship P," in progress.

P. A. W. Lewis, "A Residual Analysis for Non-Normal Time-Series with Autoregressive Correlation Structure," in progress.

P. A. W. Lewis and A. J. Lawrance, "An Exponential Structure for Time Series: Definition and Residual Analysis," in progress.

Conference
Presentations: P. A. W. Lewis, "Graphical and Statistical Methodology for Analysis of Circadian Rhythms in EEG States," Bay Area Biostatistics Colloquium, U.C. Berkeley, October 22, 1981.

P. A. W. Lewis, "Some Simple Models for Positive Valued Time Series," MIT Department of Civil Engineering, Hydrology Laboratories, December 3, 1981.

P. A. W. Lewis, "Graphical and Statistical Analysis of Sleep-Wake States in Mus Musculus," Harvard Biostatistics Department, December 4, 1981.

P. A. W. Lewis, "Graphical and Statistical Analysis of Sleep-Wake States in Mus Musculus," Office of Naval Research, December 7, 1981.

P. A. W. Lewis, "A New Exponential Time Series, NEAR(1)," North Carolina University, Joint Statistics/OR Seminar, December 8, 1981.

P. A. W. Lewis, "Simple Multivariate Time Series for Simulation of Complex Systems," 1981 Winter Simulation Conference, Atlanta, Georgia, December 10, 1981.

P. A. W. Lewis, "A Gamma Time Series Model, GLARMA(p,q), with an Application to the Analysis of Wind Velocity Data," Meteorology Department seminar, Naval Postgraduate School, April 13, 1982.

P. A. W. Lewis, "Quantile Estimation in Dependent Data," Operations Research Society of America Meeting, Detroit, Michigan, April 21, 1982.

P. A. W. Lewis, "Some Uses of Transformations in Simulation Studies," University of Birmingham-University of Wales Statistics Conference, Gregynog, Wales, April 25, 1982.

P. A. W. Lewis and A. J. Lawrance, "Simple Dependent Pairs of Exponential and Uniform Random Variables," Newark, New Jersey, May 1, 1982

P. A. W. Lewis, "A Gamma Time Series Model, GLARMA(p,q), with an Application to the Analysis of Wind Velocity Data," University of Paris, Institute of Statistics, May 3, 1982.

P. A. W. Lewis, "A Gamma Time Series Model, GLARMA(p,q), with an Application to the Analysis of Wind Velocity Data," IBM Research Center, Yorktown Heights, New York, May 24, 1982.

P. A. W. Lewis, "Some Simple Models for Positive Valued Time Series," IBM Systems Research Institute, New York, May 25, 1982.

P. A. W. Lewis, "A Gamma Time Series Model, GLARMA(p,q), with an Application to the Analysis of Wind Velocity Data," MIT Department of Civil Engineering, Hydrology Labs, May 26, 1982.

Thesis Directed: D. K. Hugus, "Extension of Some Models for Positive-Valued Time Series," Ph.D. Thesis, March 1982.

DATA: RAW 3-HOURLY WIND VELOCITIES-1965
DETRENDING: NONE
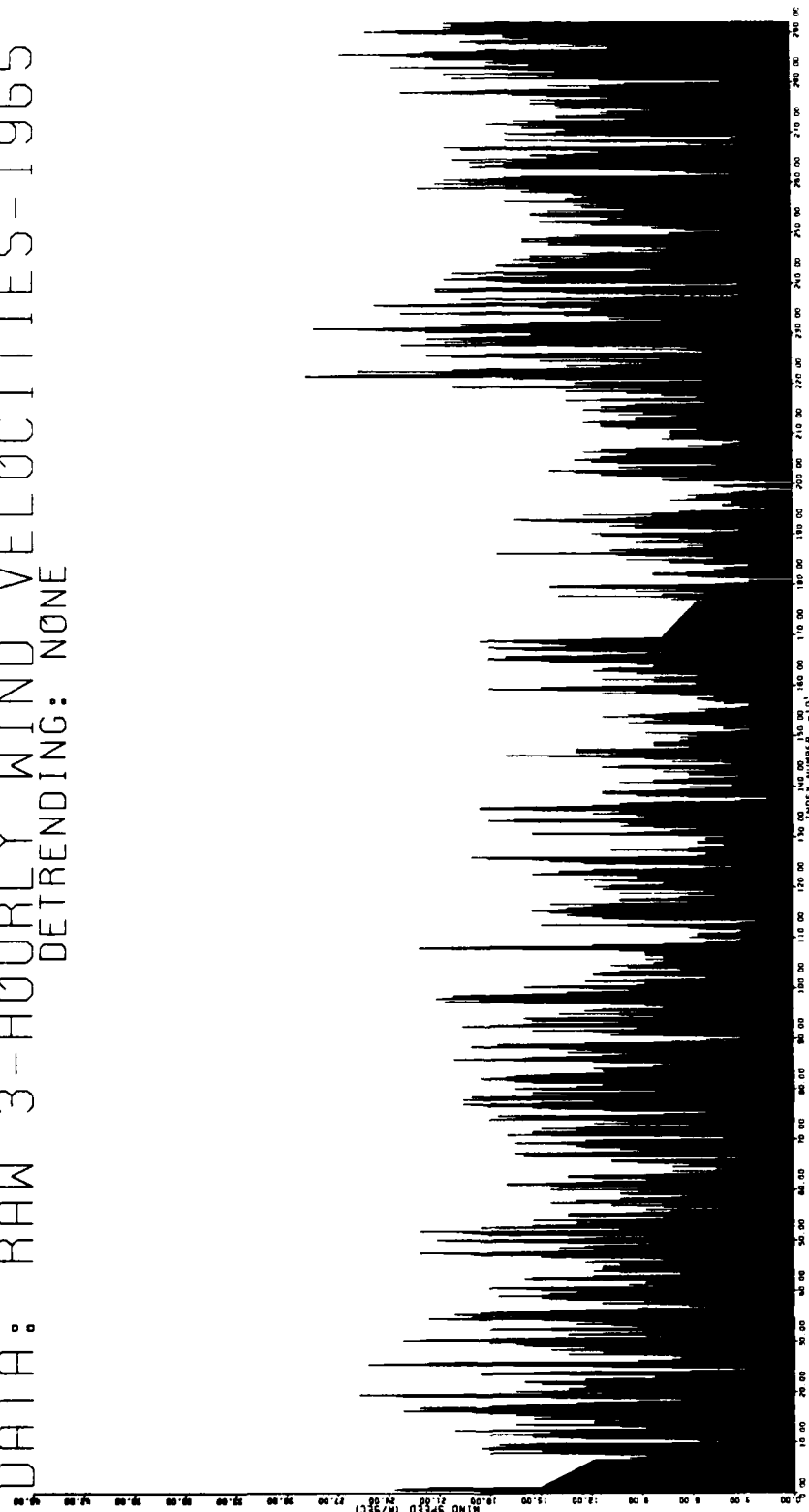
WIND VELOCITIES TAKEN EVERY THREE HOURS FOR A PERIOD OF A YEAR IN THE GULF OF ALASKA. THERE ARE SEVERAL POINTS AT WHICH THE DATA HAS CLEARLY BEEN INTERPOLATED. ANALYSIS OF THIS YEAR'S DATA AND 14 OTHER YEARS SHOWS BY SPECTRAL METHODS THAT THE DATA HAS A ONE YEAR, A SIX MONTH, A TWELVE HOUR AND A SIX HOUR CYCLIC COMPONENT. (SEE SUMMARY ON PREVIOUS PAGE FOR STOCHASTIC ANALYSIS AND SIMULATION.)

Title: Navy Officer Sea Tour Opportunity Models

Investigator: Paul R. Milch, Professor of Operations Research
                         and Statistics

Sponsor: Deputy Assistant Secretary of the Navy (Manpower)
                         and Deputy Chief of Naval Operations (Manpower,
                         Personnel and Training)

Objective: To model sea tour opportunities of the URL communities
                         of the Navy Officer Corps to enable manpower managers
                         to observe the long-term effects of policy decisions
                         and facilitate their long-range planning. This is
                         the conclusion of a four-year effort.

Summary: Final modifications were made in the three sea tour
                         opportunity models for the Surface, Air and Submarine
                         Warfare Officer communities. The models have also
                         been used to provide statistical support for the
                         restructuring of the LDO community, for the evaluation
                         of URL women officer accessions and other functions.
                         Models are now operational on OP-01's own Harris
                         computer.

Theses Directed: J. N. Lott, "An Investigation of a Steady State
                         Allocation Model for Military Manpower Planning,"
                         Master's Thesis, December 1981. Coadvised with
                         K. T. Marshall.

                         T. G. Russell, "A Navy Officer Assignment Model,"
                         Master's Thesis, March 1982.

Title: Air/Land Combat Model Research and Development

Investigators: S. H. Parry, Associate Professor of Operations Research, J. K. Hartman, Associate Professor of Operations Research, J. G. Taylor, Professor of Operations Research, A. L. Schoenstadt, Associate Professor of Mathematics

Sponsor: U. S. Army Training and Doctrine Command

Objective: To continue development and implementation of modules for the Simulation of Tactical Alternative Responses (STAR) air/land combat model. In addition, continue research to investigate a self-contained hierarchical construct for the modeling of air/land combat.

Summary: During the past five years, the investigators have conducted research leading to the development of the STAR model. STAR is designed for high resolution analysis of combined arms task force operations at the Blue Brigade-Red Division level.

A major focus of the research for this year was the continued development of the STAR combat simulation model. Significant effort was devoted to preparation of a production version of STAR for use by Fort Leavenworth on the VAX 11/780 to conduct a DA directed study on Mortars in Combat Units.

An efficient cross reference data structure for accessing STAR combat entities was developed. Research was initiated for the development of realistic modules for Red Command and Control and decision logic for the artillery and maneuver units. An improved radar detection module for the Air/Air Defense battle in STAR was completed. Efforts were initiated to include non-persistent chemical effects in STAR. Student thesis efforts are currently underway to develop modules for the representation of persistent chemical agents and nuclear effects in the model.

Modules are developed and implemented in STAR to represent FASCAM, obstacles, tank ditches, bridging, etc. Both effects and tactical decision rules were developed for these engineer functions. The communications/EW modules were refined and included in the production version of STAR. Significant enhancements were completed for the acquisition/obscuration modules and implemented in the production code.

In addition to module development for STAR, an evaluation algorithm for use by the National Training Center was developed. A communication preprocessor for the McClintic Theatre Model was developed, as well as an analysis of an ADA early warning system under investigation by the Ninth Infantry Division.

Research was continued to investigate a self-contained hierarchical structure as an alternative to a hierarchical structure which requires development of external linkages to transfer data and information to the various models in the structure. The self-contained structure begins with a model construct which represents combat from theatre down to individual item (vehicle) level. The construction permits the interchange of models at the various levels as determined by the analysis requirement.

Publications:

J. K. Hartman, "A Target Acquisition Module for the STAR Combined Arms Simulation," Volume I, Users Manual, NPS Technical Report, NPS55-82-001, January 1982.

J. K. Hartman, "A Target Acquisition Module for the STAR Combined Arms Simulation," Volume II, Technical Manual, NPS Technical Report, NPS55-82-014, April 1982.

H. Carpenter and J. K. Hartman, "Smoke and Battlefield Obscuration for the STAR Combined Arms Simulation," NPS Technical Report, forthcoming.

S. H. Parry, "A Self-Contained Hierarchical Simulation Construct," Proceedings of the NATO Symposium on Modelling and Analysis of Defense Procedures, Brussels, Belgium, 27-29 July 1982.

J. G. Taylor, "A Tutorial on the Determination of Single-Weapon-System-Type Kill Rates for Use in Lanchester-Type Combat Models," NPS Technical Report, NPS55-82-021, August 1982 (forthcoming).

J. G. Taylor, "An Introduction to Lanchester-Type Models of Warfare," in Proceedings of the 1982 Calloway Workshop on Modelling and Simulation of Land Combat, Georgia Institute of Technology, Atlanta, GA, 1982.

J. G. Taylor, "Lanchester-Type Models that Reflect Continuous Distribution of Forces," in Proceedings of the 1982 Calloway Workshop on Modelling and Simulation of Land Combat, Georgia Institute of Technology, Atlanta, GA, 1982.

Conference
Presentations:

J. G. Taylor, "Soviet Advances in the Mathematical
Analysis of Combat," copies of transparencies for
presentation given at U.S. Army Research Office,
Durham, NC, 23 August 1982.

S. H. Parry, "An Alternative Structure for the Hier-
archy of Combat Models," U. S. Army Concepts Analysis
Agency, Bethesda, MD, 15 June 1982.

S. H. Parry, "Self-Contained Hierarchical Models,"
Theory of Combat Conference, U. S. Army War College,
Carlisle, PA, 9-12 June 1982.

S. H. Parry, "A Proposed Internal Construct for Air/
Land Combat Models," 48th Military Operations Research
Symposium, Naval Postgraduate School, December 1981.

S. H. Parry, "Army Independent Evaluation of ARMVAL,"
XX Army Operations Research Symposium, Fort Lee, VA,
6-8 October 1981.

J. K. Hartman, "Target Acquisition in the STAR Combat
Simulation," 48th Military Operations Research
Symposium, Naval Postgraduate School, December 1981.

Theses Directed:

L. N. Clark, L. D. Pless and R. E. Rapp, "Communica-
tions Processor for C^3 Analysis and Wargaming,"
Master's Thesis, March 1982.

R. J. Reese, "Analysis of the RELIABLE STING Early
Warning System," Master's Thesis, March 1982.

C. R. Kaylor and R. C. Holcomb, "Analysis of
Suppression in the Simulated Tactical Alternative
Responses (STAR) Combat Model," Master's Thesis,
March 1982.

J. S. Furman and R. L. Wampler, "A Methodology for
the Evaluation of Unit Tactical Proficiency at the
National Training Center," Master's Thesis,
March 1982.

P. J. Bucha and T. J. McGrann, "A High Resolution
Ammunition Resupply Model," Master's Thesis, March
1982.

A. R. Hock and S. L. Maddox, "Electronic Warfare
Module of the Simulation of Tactical Alternative
Responses (STAR) Model," Master's Thesis, March 1982.

F. M. Maressa and J. T. Rozman, "An Investigation of Light Air Defense System in the Infantry Division," Master's Thesis, March 1982.

T. J. Pawlowski and C. J. McKenzie, "Deterministic Aggregated Model of STAR on the APPLE Computer (DAMSTAC)," Master's Thesis, March 1982.

J. V. Mudd and S. C. Main, "The Engineer Effects Module for the STAR Combat Model," Master's Thesis, March 1982.

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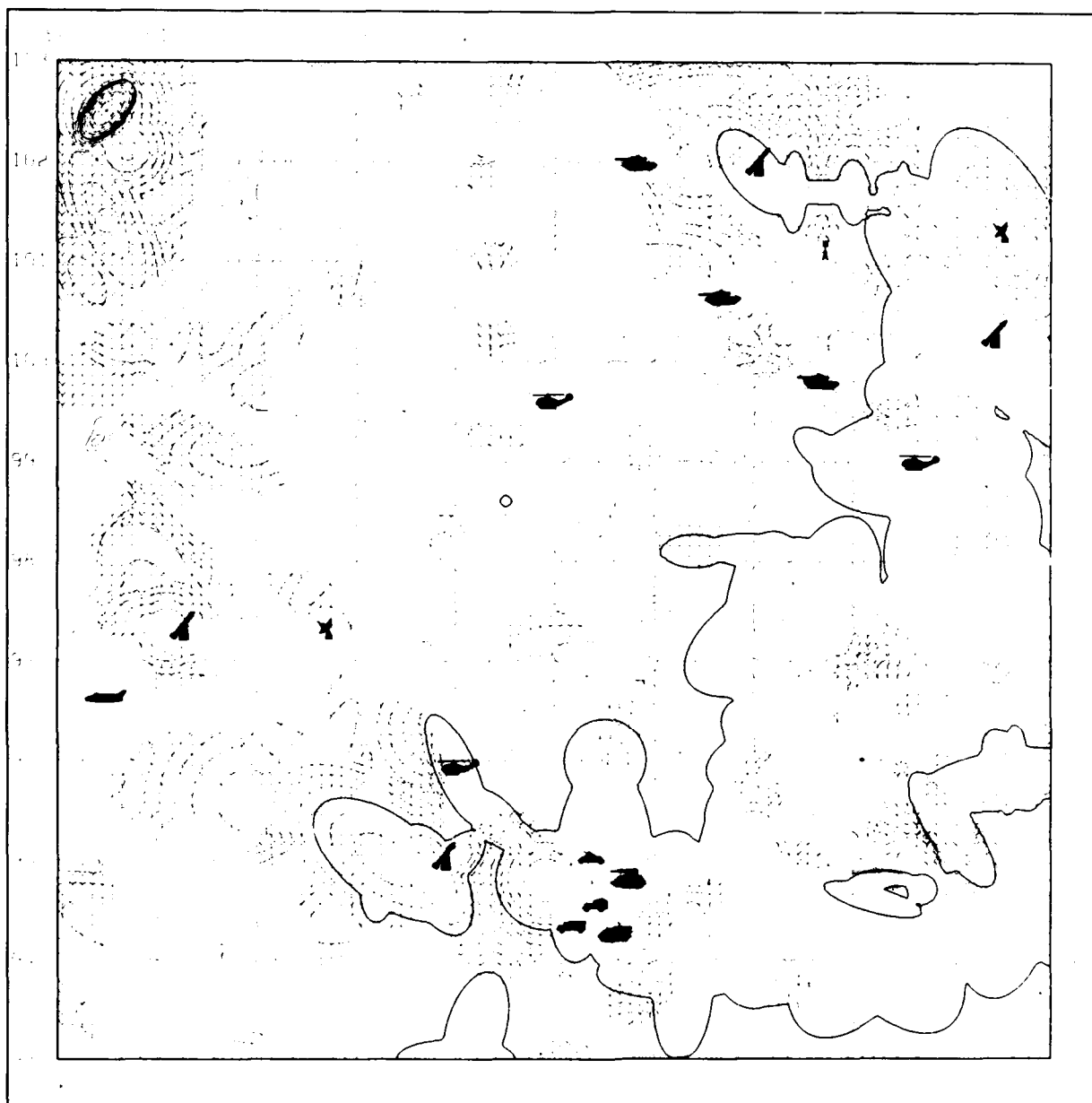
COMPUTER REPRESENTATION OF TERRAIN FOR COMBAT MODELLING. (SEE SUM-
MARY ON PREVIOUS 4 PAGES FOR AIR/LAND COMBAT MODEL RESEARCH DEVELOP-
MENT.)

Title:	Potential for Voice Recognition in TACFIRE
Investigator:	G. K. Poock, Professor of Operations Research and Man-Machine Systems
Sponsor:	9th Infantry Division, U.S. Army
Objective:	To examine the possibilities and feasibility of using current day state-of-the-art commercial voice recognition equipment for use in the TACFIRE van to allow operators to enter data via voice rather than via manual typing means.

Summary:	Basic research issues were examined in lab experiments at NPS. These included the feasibility for multiple users to use the same speaker dependent voice systems, and also an experiment which examined the feasibility of using voice entry while wearing an Army gas protective mask. In addition, we worked with the actual TACFIRE system at Fort Sill and actually integrated voice input into the artillery control console in the TACFIRE van. It appears right now that voice entry could be used in a TACFIRE situation but due to current electronics in TACFIRE, some of the good features of voice entry are negated. We probably would not retrofit current TACFIRE with voice entry, but if a new version of TACFIRE comes along with more modern electronics, then voice entry should be designed in as a natural part of the system.

Publication:	G. K. Poock and E. F. Roland, "Voice Recognition Input to the Army's Tactical Fire Direction System," Proceedings of the ONR-MIT Conference on Command and Control, Naval Postgraduate School, August 1982.
Conference Presentation:	G. K. Poock and E. F. Roland, "Voice Recognition Input to the Army's Tactical Fire Direction System (TACFIRE)," ONR-MIT Command and Control Conference, NPS, Monterey, CA, August 1982.

Title:	Voice Recognition for Command and Control
Investigator:	G. K. Poock, Professor of Operations Research and Man-Machine Systems
Sponsor:	Naval Electronics Systems Command
Objective:	To examine basic research issues in the possible application of commercial voice recognition equipment to command center types of activities and environments.

Summary:	In FY82, research was concentrated on the basic issues of: trying to achieve semi-speaker independence with speaker dependent voice recognition systems; determining if one could speak into various types of protective masks and not be heard but still have good voice recognition; and determining the effects of different types of feedback on the recognition performance of the subject's voice. In addition, in the applied area we demonstrated the feasibility of being able to use voice input into daily query operations of intelligence data bases, and also demonstrated the feasibility of being able to integrate voice input into the querying operations of the World Wide Military Command and Control System (WWMCCS).

Publications:

G. K. Poock, "To Train Randomly or All at Once... That is the Question," in _Proceedings of the Voice Data Entry Applications Conference_, Lockheed, 1981.

G. K. Poock, N. D. Schwalm and E. F. Roland, "Wearing Protective Masks: Effects on Voice Recognition System Performance," in _Proceedings of the Voice Data Entry Systems Applications '82_, Lockheed, 1982.

Conference Presentations:

G. K. Poock, "Military Applications of Advanced Speech Technology," Human Factors Society 25th Annual Conference, Rochester, NY, October 1981.

G. K. Poock, "To Train Randomly or All at Once... That is the Question," Voice Data Entry Applications Conference, Sunnyvale, CA, October 1981.

G. K. Poock, N. D. Schwalm and E. F. Roland, "Wearing Protective Masks: Effects on Voice Recognition System Performance," Voice Data Entry Systems Applications '82, San Mateo, CA, September 1982.

Theses Directed: T. R. Malarkey, "An Investigation of the Application of Voice Input/Output Technology in the COINS Network Control Center," Master's Thesis, March 1982.

F. S. Calcaterra, "Applications of Artificial Intelligence in Voice Recognition Systems in Micro-Computers," Master's Thesis, March 1982.
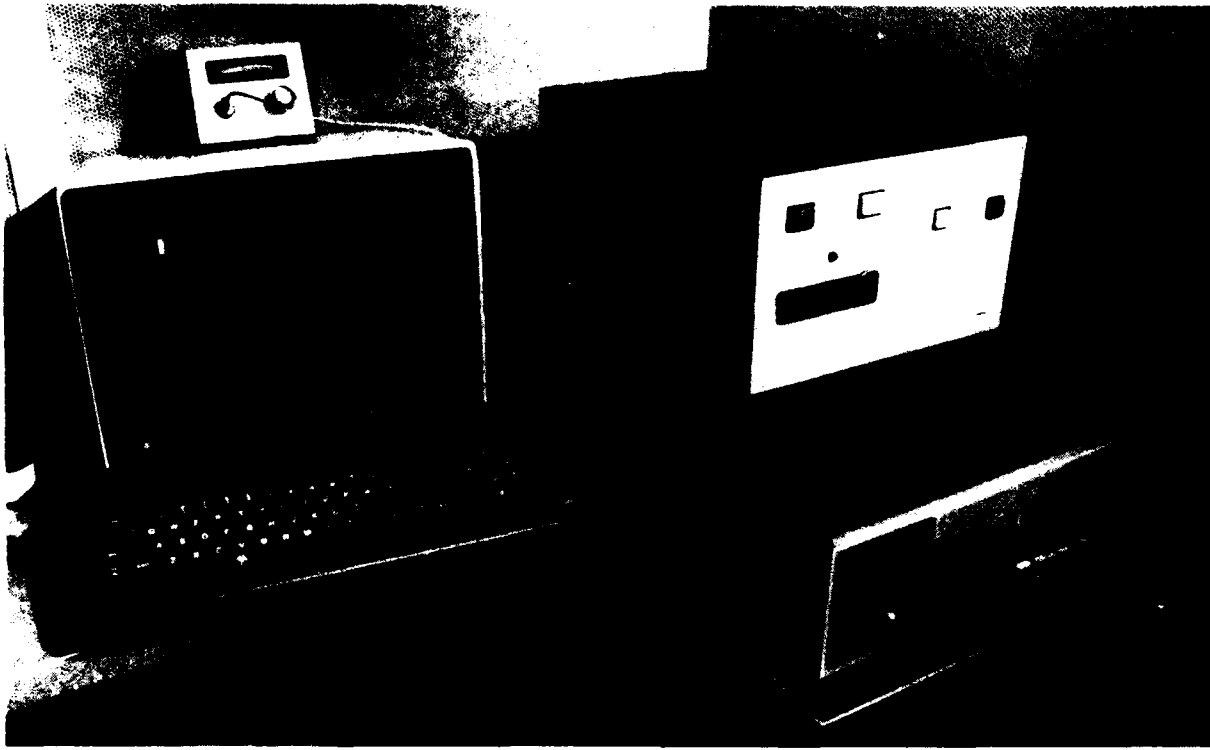
VOICE RECOGNITION EQUIPMENT USED TO CONTROL COMPUTER OPERATIONS IN THE RESEARCH CONDUCTED BY PROFESSOR GARY K. POOCK, DEPARTMENT OF OPERATIONS RESEARCH.

STUDENTS MAKING COMPUTER-CONTROLLED ELECTRICAL MEASUREMENTS ON A
SONAR TRANSDUCER.

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Title: Torpedo Track Smoothing

Investigator: R. R. Read, Professor of Operations Research

Sponsor: Naval Undersea Warfare Engineering Station

Objective: To find suitable data smoothing filters that can
                    be applied to torpedo tracking data in the post
                    test analysis of such exercises. It is important
                    to have the capability to identify legitimate
                    maneuvers apart from noise and other anomolies.

Summary: Some standard polynomial and low-pass digital filters
                    have been applied to a processed torpedo track and
                    the track of its target. The residual (difference
                    of data from smoothed data) processes have been
                    studied for their statistical behavior. It appears
                    that such behavior is highly dependent on the
                    distance from the sensing arrays and is quite
                    variable. Nor are they the same for both torpedo
                    and target. Also, we are not yet able to identify
                    whether a given filter oversmooths or undersmooths.

Publication: R. R. Read, "A Comparison of Polynomial and Low
                    Band Pass Data Smoothing Filters," NPS Technical
                    Report, NPS55-82-006, January 1982.

Title: Wholesale Provisioning Model in Provisioning
                    Prototype

Investigators: F. R. Richards, Associate Professor of Operations
                    Research; A. R. McMasters, Associate Professor of
                    Operations Research and Administrative Sciences;
                    G. T. Howard, Associate Professor of Operations
                    Research

Sponsor: Navy Fleet Material Support Office

Objective: Develop and evaluate uniform provisioning criteria
                    compatible with the current UICP replenishment
                    model and DODI 4140.42 cost constraints.

Summary: The existing models and guidelines used for whole-
                    sale provisioning of new weapon systems within the
                    Navy were examined carefully, and an extensive
                    review of the literature was made. Several decision
                    criteria were considered and, for each criterion, a
                    spares allocation algorithm was developed to opti-
                    mally allocate spares subject to the DODI 4140.42
                    cost constraints. Actual provisioning data have
                    been identified and will be used to evaluate the
                    new models. Analyses will be performed to explore
                    the sensitivity of system effectiveness to the
                    various model parameters. Preliminary model results
                    were presented to the sponsor.

Publication: F. R. Richards and A. R. McMasters, "New Wholesale
                    Provisioning Models," forthcoming.

Title:	Cost Control Methodology
Investigator:	Michael G. Sovereign, Professor of Operations Research
Sponsor:	Office of the Assistant Secretary of Defense (Comptroller)
Objective:	To review methods of estimation and monitoring of costs of major projects in DOD. Emphasis is on improving the timeliness and quality of information for the upper-level management of DOD.
Summary:	This effort is a continuation of research started while the investigator was serving in OSD in FY81. The new USDR&E desired an alerting system of cost and/or schedule overruns in major weapon systems. This effort was designed to take an overall view of the problem and suggest improvements. Subsequently a new system was suggested by others and was reviewed by the investigator. A letter report was given to the sponsor on this topic. A paper reviewing the overall problem was prepared. Research on the prediction of overruns from early data was conducted.
Conference Presentation:	J. Borsting, Comptroller of DOD on Costing, Plenary Address, ORA-TIMMS Meeting, San Diego, November 1982.
Thesis Directed:	Henry Watkins III, "An Application of Rayleigh Curve Theory to Contract Cost Estimation and Control, Master's Thesis, March 1982.

Title:	Static Measures for Chemical Weapons
Investigator:	James G. Taylor, Professor of Operations Research
Sponsor:	Defense Communications Agency
Objective:	To develop improved methodology for determining force-balance conditions for ground-combat units within the context of potential use of chemical weapons (i.e. to provide improved measures of the strength of chemical inventories). Specific objectives included the review of work on "static measures" by the Institute for Defense Analyses (IDA) and the investigation of alternate methods and/or enhancements to existing methodology.
Summary:	The IDA work on static measures was reviewed and critiqued, and this evaluation work led to investigation of the general problem of estimation of the combat potential of a weapon system. A first cut on methodology for estimating the combat potential of a weapon system was consequently produced. A letter report documenting all such progress was sent to the sponsor. Student work has focused on data-base development to support such evaluative work.
Publication:	J. G. Taylor, "Preliminary Investigation of Improved Methodology for Static Measures for Chemical Weapons," NPS Letter Report, September 1982.
Thesis Directed:	W. C. Grubb, "Investigation of Chemical-Agent-Effectiveness Data," Master's Thesis, March 1983.

Title: Instrumental Range Studies - Torpedo Track Smoothing

Investigator: J. B. Tysver, Associate Professor of Operations
                      Research

Sponsor: Naval Undersea Warfare Engineering Station (NUWES)

Objective: To develop theory and computational procedures to
                      improve existing track smoothing programs in use at
                      NUWES.

Summary: The research covered in this report is a continuation
                      of the effort to improve and extend the general 3-D
                      data processing program in current use at NUWES.
                      The following results were obtained:

                      1) Examination of the differences in data from the
                      Shallow Water Range (Quinalt) from that from the
                      other NUWES ranges which can affect track smoothing
                      was again postponed pending availability of data.

                      2) Investigation of the Array Cross-Over problem
                      was initiated. 3-D data currently provided to the
                      Proof and Test department by the Instrumentation
                      department includes identification of the array
                      producing the data at any observational time but
                      does not provide observations from more than one
                      array at any one time. Simultaneous observations
                      from both arrays will be needed to provide a basis
                      for a more thorough investigation of this problem.

                      Preliminary examination of data from one trial did
                      not indicate a serious cross-over problem between
                      two arrays in one case. In another case an apparent
                      offset of target path for which array mismatch was
                      suspected as the cause could not be substantiated
                      since data on both sides of the suspected offset
                      were produced by the same array. Also, multiple
                      missing points in the vicinity of the offset make
                      it difficult to determine the actual target path
                      in the vicinity of the apparent offset.

                      3) Examination of the geometry of attacker and
                      target in the vicinity of intercept was initiated.
                      Procedures for determining (a) distance between
                      vehicles, (b) projected miss distance, (c) attack
                      angle, and (d) line of sight angle were developed
                      for any observation time.

4) A brief examination of the treatment of a simple dog-leg target path by the 7-point Least Squares Linear Smoothing and by a Second Order Kalman Filter was undertaken to illustrate the nature of the two methods of data smoothing.

Publication: J. B. Tysver, "Selection of Segment Length for Least-Squares Polynomial Smoothing of 3-D Data," Letter Report, January 1982.

Title:	Countered Minefield Planning: Area/Count Considerations
Investigator:	Alan Washburn, Professor of Operations Research
Sponsor:	Office of Naval Research
Objective:	To investigate how the density of mines per unit area should depend on channel shape.
Summary:	When the minefield is countered by sweeping, the density question cannot be separated from the question of mine count settings. It turns out that mines should be most dense and on the highest count settings at the narrowest part of the channel.
Publication:	A. Washburn, "Countered Minefield Planning: Area/Count Considerations", NPS Technical Report, NPS55-82-013, April 1982.

Title: Myopic Sequential Testing Procedures for Greatest
                    Mean Selection

Investigator: Alan Washburn, Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To investigate the efficiency of myopic as compared
                    to optimal testing procedures.

Summary: Myopic procedures were tested in two problems:
                    selecting the component type with the greatest
                    reliability, and selecting the category with the
                    greatest mean using noisy tests. The myopic procedure
                    is nearly optimal for the first problem, and is more
                    efficient than other procedures for the second.
                    Comparisons were made by computer simulation.

Publication: A. Washburn, "Bayesian, Sequential Methods for
                    Selecting the Greatest Mean", Journal of the American
                    Statistical Association, submitted September 1982.

Title:	Research in Tactical Analysis
Investigators:	A. R. Washburn, Professor of Operations Research, A. F. Andrus, Associate Professor of Operations Research, R. N. Forrest, Professor of Operations Research, P. A. Jacobs, Associate Professor of Operations Research, R. H. Shudde, Associate Professor of Operations Research
Sponsor:	Office of Naval Research
Objective:	To estimate the increase in the level of support of air HSW operations that would result from replacing the HP-67/97 programmable calculator system with a more advanced system.
Summary:	The HP-41CV programmable calculator was one of the advanced systems studied. A LORAN-C position fixing algorithm was developed to take advantage of the advanced features of the HP-41CV system. This LORAN-C implementation was compared with an existing LORAN-C implementation for the HP-67/97 system. The LORAN-C algorithm was selected for this investigation because its massiveness is a critical test of the calculators' capabilities. A second evaluation was a student comparison of the HP-41CV and Casio FX702P systems.
Publications:	R. H. Shudde, "Position Determination with LORAN-C Triplets and the Hewlett-Packard HP-41CV Programmable Calculator," NPS Technical Report, NPS55-82-022, September 1982.
	R. H. Shudde, "A Comparison of the Hewlett-Packard HP-67 and HP-41CV Programmable Calculators," NPS Technical Report, NPS55-82-023, September 1982.
	R. H. Shudde and R. N. Forrest, "A Comparison of the Hewlett-Packard HP-41CV and Casio FX702 Programmable Calculators," NPS Project Report, NPS55-82-025PR, September 1982.
Thesis Directed:	W. D. Duym and E. S. Zapolski, "Comparison of the HP-41CV versus the HP-67," Master's Thesis, October 1982.

Title: Shortest Route Problems in Tracking Data Association

Investigator: Alan Washburn, Professor of Operations Research

Sponsor: None

Objective: The problem of tracking a target is often made difficult
                    by the presence of false alarms. If the available
                    data consists of a sequence of measurements, the
                    problem is to divide the measurements into two sets:
                    the false ones and the real ones. The objective is
                    to provide an efficient method for doing this.

Summary: Using Kalman Filter methodology, a "distance" is
                    defined in such a manner that the estimated set of
                    real measurements are all those lying on the shortest
                    path from the last known real measurement. The
                    procedure is very efficient. The quality of its
                    estimates is investigated by simulation.

Publication: A. Washburn, "Shortest Route Problems in Tracking
                    Data Association", IEEE Transactions on Aerospace
                    and Electronic Systems, submitted July 1982.

DEPARTMENT

OF

NATIONAL SECURITY AFFAIRS

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

Research interests of the Department of National Security Affairs conform in general to the curricula covered, namely (1) Geographical Area Security Studies, including the Middle East, Africa, South Asia, the Far East, Southeast Asia, the Pacific Basin, Europe and the USSR, and (2) Functional Specialty Studies, including International Organizations and Negotiations, Strategic Planning, and Intelligence. The research efforts are accordingly broad, focussing on the security interests of the United States in conjunction with other major international entities. Particular emphasis is placed upon the role of the military with respect to world wide economic, political, legal, technological, cultural and historical factors which shape the global interests, capabilities and security policies of the United States. The general areas of research, then, are as follows:

REGIONAL POLITICO MILITARY ANALYSIS

These analyses have continued to focus on those areas of the world of vital interest to the United States, including Europe, Asia, the Middle East/Southwest Asia, and Africa.

Ongoing research in the European region resulted in the publication of books entitled NATO's Strategic Options: Arms Control and Defense, Pergamon Press, 1981, and Tank Armies and Potemkin Villages: New Realities in Deterrence and War Fighting in Central Europe, Van Hase and Koehler, 1982. The first phase of the research project "Models of European Security" was completed. This phase focused on identifying and analyzing alternative structural systems of European security. Phases II and III will examine underlying reasons for changing perceptions and policy alternatives likely to face the United States in the future. The research project on "French Security Policies" is also continuing with the objective of advancing the understanding of French policies with respect to European security.

Research in the Asian area resulted in the publication of the United States and the Republic of Korea: Background for Policy, Hoover Institution Press, 1982, and Chinese Communist Politics: Selected Studies, Asian Research Service, 1982. A conference on "The Role of the Armed Forces in Contemporary Asian Societies" was sponsored by and held at the Naval Postgraduate School August 4-6, 1982 with wide participation by leading Asian scholars and U. S. government officials. The conference report is in preparation and the papers are being edited for publication in 1983 by Duke University Press.

A research proposal has been submitted to examine the strategic thinking in contemporary Japan, classifying it according to its viability and influence within Japan and to assess its probable impact on friends, allies and potential antagonists.

Recent publications resulting from research in Middle East Studies include Economic Origins of the Iranian Revolution, Pergamon Press, 1982 and Saudi Arabia's Development Potential, D. C. Heath and Co., 1982.

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Several additional publications resulting from faculty research adjunctive to teaching in the Middle East/Southwest Asia curriculum are in process including Gulf Security into the 1980's: Perceptual and Strategic Dimensions, Hoover Institution Press, expected 1983, and Responding to Crises in Southwest Asia, Syracuse University Press, 1983. In addition, a conference on "Afghan Alternatives" has been scheduled for 1983, to be held on the fifth anniversary of the April 1978 communist coup which resulted in the Soviet invasion of December 1979. The theme of the conference, tentatively to be sponsored jointly by the U. S. Information Agency and the Naval Postgraduate School, will be to examine alternative strategies and policies to be adopted and/or coordinated between the United States, the Afghan national resistance movements, friendly states and other interested parties to secure removal of the Soviet armed forces and the restoration of an independent Afghan government.

Sub-Saharan African research included a conference held in May, 1982, entitled "Africa in the 1980's: Continuity and Change" as well as a faculty book Changing Realities in Southern Africa: Implications for American Policy, Institute of International Studies, University of California, Berkeley, 1982, which was also written as a result of research adjunctive to teaching. In furtherance of this effort, a conference is to be held in February 1983 on "The Future of Relations between the United States and South Africa: Conflict on Cooperation?" which has already attracted senior participation from government policy makers and leading academics.

In the general area of U. S. Defense Policy, a major manuscript is in preparation on "The Role of Congress in Defense Policy" for presentation at a June 1983 conference in Washington, D. C. Preliminary results of this research indicate that there is a decrease in the anti-defense bloc in the Congress, committee action is increasingly strategic in nature, the new budget process has failed to change the line item orientation of Congress, and that the micro-management criticism of the Congress is exaggerated.

SOVIET AND EASTERN EUROPEAN POLITICO-MILITARY ACTIVITIES

Research projects completed while on leave of absence as the recipient of four fellowships to Associate Professor Valenta by the Council on Foreign Relations, the Rockefeller Foundation, the National Endowment for the Humanities, and the Bellagio Study and Conference Center included "Soviet Interventions in Neighboring Communist Countries: Implications for the United States," "USSR and Cuba in Critical Regions of the Third World: Central America," and "The Polish Crisis and Eastern Europe."

Publications resulting from ongoing research include chapters in books of collected readings as follows: "The Caribbean Policy of the USSR" in Colossus Challenges, Westview Press, 1982; "The USSR, Cuba and Crisis in Central America" in The International Aspects of the Crisis in Central America, Holmes and Meyer, 1982; "Czechoslovak Armed Forces: Origins and Development" in Communist Armies and Politics, Westview Press, 1982; and "Soviet Interests, Objectives and Policy Options in Southwest Asia" in U. S. Strategic Interests in Southwest Asia, Praeger Press, 1982.

STRATEGIC MILITARY DECEPTION

Ongoing research in this area resulted in the publication of a book, _Strategic Military Deception_, Pergamon Press, 1982, edited by Professors Daniel and Herbig and containing multi-disciplinary contributory chapters by ten Naval Postgraduate School faculty members.

The related research in the perception area has been completed and a manuscript is in preparation on the "Trends in Anti-Submarine Warfare and Their Implications for Strategic Stability."

Research proposals have been submitted to examine Strategic Thought in World War II, the Lessons of the Normandy and Pacific Campaigns for U. S. Navy Strategic/Departmental Deception, and the Theory and Practice of Cross-Cultural Perception Management.

OPERATIONAL TEST AND EVALUATION

The reports and analyses of the effectiveness of the A-10 aircraft firing against simulated Soviet tank formations are continuing in conjunction with the Air Force Combat Damage Assessment Team.

Title: Trends in ASW Effectiveness and Their Implications
                    for Strategic Stability

Investigator: D. C. Daniel, Associate Professor of National Security
                    Affairs

Sponsor: The Ford Foundation

Objective: Research conducted during AY81-82 is part of a contin-
                    uing program to investigate open-literature claims
                    about trends in the effectiveness of U.S. and Soviet
                    antisubmarine warfare capabilities and the impact of
                    these trends on strategic stability.

Summary: Research during this reporting period has concentrated
                    on reviewing unclassified scientific information on
                    possible ASW observables and sensors. The information
                    is drawn mainly from physics, oceanographic, and re-
                    mote sensing literature. The thrust of the research
                    is that trends in antisubmarine capabilities are not
                    strategically destabilizing.

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Title:	The Role of Congress in Defense Policy
Investigator:	E. J. Laurance, Associate Professor of National Security Affairs
Sponsor:	NPS Foundation Research Program
Objective:	To update the indicators of the Congressional role in defense policy which were developed in previous work of investigator (e.g. number and type of committee staffs, quantity of hearings, budgetary, decisions by each committee, floor debate, etc.).
	To describe and explain the organizational and behavioral characteristics at DoD-Congressional relations.
	To assess the impact of the 1974 Congressional Budget and Impoundment Control Act on the defense budget process.
Summary:	Some examples of preliminary results include the following: a statistical analysis of roll-call votes reveals a decided decrease in the anti-defense bloc which prevailed from 1969 to 1974; committee action continues to be increasingly strategic in nature; the Congressional Budget office has achieved its stated goal of independent analysis but only in structural issues such as personnel matters; the new budget process has failed to change the line-item orientation of Congress; the micro-management criticism of Congress is exaggerated.
Conference Presentation:	As a result of this research and the preliminary results, the investigator has been given a contract by the Roosevelt Center for American Policy Studies to complete a major manuscript for a June 1983 conference in Washington. Government officials and private experts will attend. The aim of the conference is the production of strategies to improve the defense budgetary process.

Title: Research Project on Employment, Trade and North-South
                    Cooperation -- Mexico (Phase II)

Investigator: Robert Looney, Associate Professor of National
                    Security Affairs

Sponsor: International Labor Office, Geneva

Objective: The principal objectives of the study were to deter-
                    mine: (a) what have been the main factors in the
                    successful economic performance of the Newly Indus-
                    trializing Countries (NICs), and what has been the
                    role of policy in their success, (b) what has been
                    the contribution of the export sector to the NICs
                    success, (c) what are the internal dynamics of the
                    economic development in the NICs. What causes their
                    "moving on" as witnessed in their changing output
                    mix.

Summary: Mexico's economic success in the post World War period
                    has been due largely to the country's stable invest-
                    ment climate, high level of government investment, and
                    relatively free trade policy orientation. It can be
                    shown that whenever the country has deviated from
                    these policies, economic growth has suffered and that
                    the economy has been able to sustain high rates of
                    economic growth only during periods when the above
                    conditions were present.

Publication: Robert Looney, "Trade, Employment and Industrializa-
                    tion in Mexico," International Labor Office, Geneva,
                    World Employment Programme, Research Working Papers
                    (February 1983), pp. 418.

Title:	The Role of the Armed Forces in Contemporary Asian Societies
Investigator:	E. A. Olsen, Associate Professor of National Security Affairs
Sponsor:	NPS Foundation Research Program
Objective:	To examine the political, economic, and cultural roles of the armed forces in eighteen Asian countries.
Summary:	The investigator prepared a paper on the societal roles of the ROK armed forces, using guidelines he devised as a thematic framework. The same framework was utilized by 17 other Asian studies specialists in preparing their papers for presentation at a NPS-sponsored conference on this topic in August. The papers and an assessment synthesizing their findings into an overview of the roles of Asian armed forces is being prepared.
Publications:	A conference report is being prepared.
	The papers are being edited and revised for publication in 1983 by Duke University Press, forthcoming.

Title: Maritime Theatre Nuclear Warfare: A Net Assessment
                    of the Soviet and United States Posture, Doctrine,
                    Tactics and Capabilities relating to Nuclear War
                    at Sea, and a Maritime Nuclear Support to the
                    Land Battle

Investigator: P. J. Parker, Professor of National Security Affairs

Sponsor: Chief of Naval Operations and the Defense Nuclear
                    Agency

Objective: To identify actions needed to improve the nuclear
                    deterrent posture of the U. S. Navy (excluding the
                    SSBN force)

Summary: The investigator headed a team of scientists and
                    policy analyst (outside the Naval Postgraduate
                    School). The team analyzed Soviet naval doctrine,
                    weapons, weapon systems and forces and examined the
                    operation of the United States naval battle groups
                    performing their missions when opposed by present
                    and future Soviet forces. Key vulnerabilities
                    in doctrine, tactics, training, weapons, weapon
                    systems, C^3, ships and aircraft were identified
                    and recommendations for near term high leverage
                    actions were made and in many cases have been
                    carried out.

Publication: P. J. Parker et al. Final report of the Maritime
                    Theatre Nuclear Warfare Working Group of the CNO
                    Executive Panel, for the Chief of Naval Operations,
                    Washington, D. C., December 1982. Arlington, VA:
                    R & D Associates, 29 December 1982.

Conference   P. J. Parker and J. Sternberg, "Maritime Theatre
Presentations: Nuclear Warfare," for OP-95, Washington, D.C.,
                    February 1981.

P. J. Parker and J. Sternberg, "Maritime Theatre
Nuclear Warfare," for Vice Chief of Naval
Operations, Washington, D. C., February 22, 1982.

P. J. Parker and J. Sternberg, "Maritime Theatre
Nuclear Warfare," for Assistant Secretary of
Defense for Atomic Energy, Washington, D. C.,
February 24, 1982.

Title: Enterprise Efficiency and Soviet Economics

Investigators: S. Rosefielde, Adjunct Professor of National Security
                  Affairs, and P. J. Parker, Professor of National
                  Security Affairs

Sponsor: Office of the Director of Net Assessment
                  Office of the Secretary of Defense

Objective: To assess the level of Soviet Enterprise Efficiency
                  and ascertain whether Soviet growth might be rein-
                  vigorated during the 1980s by improvements in enter-
                  prise efficiency.

Summary: The investigator carried out a series of frontier
                  production function estimates with the assistance of
                  Knox Lovell and two Soviet economists. Preliminary
                  results indicate a surprisingly high level of ef-
                  ficiency in the Soviet cotton refining sector.

Publication: Rosefielde, Lovell, Materov, Danilin, "Measuring and
                  Improving Efficiency in the Soviet Union," _Economica_,
                  accepted subject to revision.

Title:	The Polish Crisis and Eastern Europe
Investigator:	J. Valenta, Associate Professor and Coordinator of Soviet and East European Studies of National Security Affairs
Sponsor:	Council on Foreign Relations
Objective:	To organize and direct a group of leading policy-makers, bankers, scholars and opinionmakers to assess the impact of the Polish crisis upon the Soviet and Western alliance systems.
Summary:	In October 1981, the President of the Council on Foreign Relations, Winston Lord, and the Director of Studies at the Council, Paul Kreisberg, asked Jiri Valenta to organize and direct a group to assess the Polish crisis, its impact on Eastern Europe, and the implications for U. S. security. Professor Valenta worked as a group director with Lt. General Brent Scowcroft, who served as Chairman of the group sessions. Among those selected to participate were Zbigniew Brzezinski, Ambassador William Hyland, A. Lee Kjellern, Vice-President, Manufacturer's Hanover Trust Co., Ernest Lee, Director, Department of International Affairs, AFL-CIO, Admiral Robert Inman, Professor Robert Jervis, Columbia University, Norman Podhoretz, editor of <u>Commentary</u>, General Edward L. Rowney, Ambassador Helmut Sonnenfeldt, and leading journalists, businessmen, and bankers. The deliberations of the group, which met several times in 1982, will be of particular importance because of the declaration of martial law in Poland. The group discussions and drafted recommendations were recorded as interim reports for the Council on Foreign Relations, whose membership includes many senior people from the U. S. government and business community.
Publications:	Reports for the Council on Foreign Relations.

Title: Soviet Decisionmaking for National Security

Investigators: J. Valenta, Associate Professor and Coordinator of Soviet and East European Studies of National Security Affairs and W. Potter, Associate Director of the Center for Strategic and International Studies, UCLA

Sponsors: Center for Strategic and International Studies (UCLA)

Objective: To develop a conceptual framework for the analysis of Soviet decisionmaking for national security affairs, including Soviet R and D and use of military force.

Summary: A major international conference with leading scholars in Soviet national security affairs in the U. S. A. and United Kingdom was convened. The participants included Ambassador W. G. Hyland, former Deputy Assistant Advisor for National Security Affairs to President Ford; Ambassador R. Garthoff, member of the U. S. SALT negotiating team, and other scholars and analysts from the DoD, National Security Council, CIA, RAND, Brookings Institution, and leading American and British universities. Research findings were integrated by the principal investigators who developed a number of hypotheses about Soviet national security decisionmaking. The research project was prepared for final publication (edited and revised) by the principal investigators in Winter 1983. (Valenta authored two chapters and the introduction).

Publications: J. Valenta and W. Potter (eds.), Soviet National Security Decisionmaking (London: Allen and Unwinn Publishers, 1983).

                    J. Valenta, "Soviet Decisionmaking on Afghanistan," in J. Valenta and W. Potter (eds.), Soviet National Security Decisionmaking (London: Allen and Unwinn, 1983).

                    J. Valenta, "Soviet Decisionmaking and the Czechoslovak Crisis," in J. Valenta and W. Potter (eds.), Soviet National Security Decisionmaking (London: Allen and Unwinn, 1983).

                    J. Valenta, "With Suslov Gone," The New York Times, February 17, 1982.

Conference
Presentations: J. Valenta and S. Butler, "Soviet Interests in Southwest Asia: Implications for the United States," Symposium on U. S. Strategic Interests in Southwest Asia, Strategic Studies Institute, U. S. Army War College, October, 15-16, 1981.

Title	Soviet Interventions in Neighboring Communist Countries: Implications for the United States
Investigator:	J. Valenta, Associate Professor of National Security Affairs and Coordinator of Soviet and East European Studies
Sponsors:	Council on Foreign Relations, Rockefeller Foundation (New York), Rockefeller Center in Bellagio (Italy), National Endowment for the Humanities, Research Institute on International Change of Columbia University, Woodrow Wilson International Center for Scholars of the Smithsonian Institution
Objective:	To develop a new conceptual framework in which to analyze the Soviet propensity toward use of force in neighboring Communist countries and implications of Soviet military interventions for the United States.
Summary:	In depth research conducted on Soviet invasions of Hungary (1956), Czechoslovakia (1968), Afghanistan (1979), and the military intimidation of Poland in 1956 and 1980-81. A new conceptual framework for comparing these cases has been developed and effort was made to establish new guidelines and recommendations for future U. S. preventive diplomacy. The results of the first study will be tested with leading U. S. policymakers and their advisors in the spring and summer of 1983 under sponorship of the Woodrow Wilson International Center for Scholars of the Smithsonian Institution. A book, now in its rough draft state, will be written in culmination of research. Publication is projected for 1983-84. Meanwhile advance portions have appeared in scholarly journals and other edited volumes.
Publications:	J. Valenta, "USSR: What Kind of Normalization in Poland," The Washington Quarterly, Vol. 5, No. 4, Autumn 1982, pp. 105-19.
	J. Valenta, "Soviet Use of Surprise and Deception," Survival, Vol. XIV, No. 2, March-April 1982, pp. 50-67.
	J. Valenta, "Deception, Surprise and the USSR: Soviet Invasions of Czechoslovakia and Afghanistan," in D. Daniel and K. Herbig (eds.) Soviet Military Deception (New York: Pergamon Press, 1982), pp. 335-51.

Conference
Presentations:

J. Valenta, "Avoidance of Conflict between the
Superpowers at the Periphery," XIIth World Congress of
the International Political Science Association
(IPSA), Rio de Janeiro, Brazil, August 1982.

J. Valenata, "Soviet Military Interventions," XXth
Western Slavic Conference, Honolulu, Hawaii, March
21-23, 1982.

J. Valenta, "Soviet Use of Surprise and Deception,"
Research Seminar for Fellows, Research Institute
on International Change (RIIC), Columbia University,
November 14, 1981.

Thesis Directed: R. Bartholomy, "Soviet Secret Service," Master's
Thesis, December 1981.

Title:	USSR and Cuba in Critical Regions of the Third World: Central America
Investigator:	J. Valenta, Associate Professor and Coordinator of Soviet and East European Studies of the National Security Affairs
Sponsor:	Office of Net Assessment of DoD
Objective:	To assess the Soviet and Cuban strategic objectives in the Caribbean basin and analyze their regional policies.
Summary:	An intensive survey of Soviet and Cuban joint strategy in the Third World was completed and Soviet and Cuban strategic objectives in the Caribbean basin were identified. The pattern of Soviet naval deployment and military involvement in Cuba and arms transfers to Cuba, Nicaragua and Grenada have been determined as well as the pattern of joint Soviet-Cuban multi-dimensional involvement in the region. The factors constraining or mitigating against Soviet and Cuban assertive posture in the region were analyzed and the implications were drawn for U. S. policymakers.
Publications:	J. Valenta, "Soviet Strategy in the Caribbean Basin," Naval Review: Issue of Naval Proceedings, May 1982, pp. 168-71.
	J. Valenta, "The USSR, Cuba and Crisis in Central America," ORBIS, Vol. 25, No. 3, Fall 1981, pp. 715-46.
	J. Valenta, "The USSR, Cuba and Crisis in Central America," in R. Feinberg (ed.), The International Aspects of the Crisis in Central America (New York: Holmes and Meyer, 1982), pp. 127-159.
	J. Valenta, "The Caribbean Policy of the USSR," In H. M. Erisman and J. Martz (eds), Colossus Challenged: The Struggle for Caribbean Influence (Boulder: Westview Press, 1982), pp. 47-83.
	J. Valenta, "On the Falklands Crisis: Moscow and Havanna," The New York Times, June 23, 1982.

Conference
Presentation: J. Valenta, "Empire Strikes Back: Falkland Islands
                       Crisis," Conference on Atlantic Alliance and Discord
                       Outside Europe, The Graduate School of New York City,
                       July 7-9. 1982.

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Title:	French Security Policies
Investigator:	D. S. Yost, Assistant Professor of National Security Affairs
Sponsors:	Fritz Thyssen Foundation and International Institute for Strategic Studies
Objective:	To advance understanding of French policies in several areas, including nuclear weapons programs, interventionary forces, arms control, and European security.
Summary:	Research to date has focused on the French strategic studies community, policy-making processes, interventionary capabilities and contingencies in Africa, nuclear weapons targeting, and policies regarding European security. In each of these areas, the existing literature in French and English has been thoroughly reviewed, and numerous interviews with French officials have supplemented and clarified published sources.
Publications:	D. S. Yost, "Strategic and International Affairs Research in France," Orbis, vol. 25 (Fall 1981), pp. 801-815.
	D. S. Yost, "The Socialists in the French Defense Debate," Armed Forces and Society, vol. 8 (Winter 1982), pp. 334-345.
	D. S. Yost, "French Policy in Chad and the Libyan Challenge," Orbis, vol. 27, Winter 1983.
	D. S. Yost, "British and French Strategic Nuclear Targeting," in Strategic Nuclear Targeting, edited by D. Ball and J. Richelson, Ithaca: Cornell University Press, forthcoming.
	D. S. Yost, "French Foreign and Defense Policies," Strategic Survey 1981-1982, pp. 61-64, London: International Institute for Strategic Studies, 1982.
	D. S. Yost, Review of P. Lellouche, ed., La Sécurité de l'Europe dans les Années 80: Les Relations Est-Ouest et le Théâtre Européen in Survival, vol. 23 (November/December 1981), pp. 284-285.
Thesis Directed:	D. L. Leonard, "France, West Germany, and the Security of the Persian Gulf," Master's Thesis, March 1982.

Title: Models of European Security

Investigator: D. S. Yost, Assistant Professor of National Security
                    Affairs

Sponsor: Office of Net Assessment

Objective: To clarify changing West European perceptions of
                    alternative structural systems of European security,
                    and to advance understanding of the objective reali-
                    ties that promote these changing perceptions - e.g.,
                    generational shifts in leadership elites, economic
                    and energy prospects, and divergent assessments of the
                    Soviet threat.

Summary: The first phase of this project (Spring and Summer
                    1982) focused on identifying and analyzing alternative
                    structural systems of European security prominent
                    among elites in Britain, France, and the Federal
                    Republic of Germany. Extensive field research --
                    including 80 interviews with West European
                    politicians, officials, scholars, and journalists
                    --was completed during this research phase. A 32-page
                    interim informal report was presented to the Office
                    of Net Assessment in September, and the Phase I
                    report was submitted in December 1982. Review by
                    sponsor of the Phase I report will determine whether
                    Phases II and III of the proposed project will be
                    funded.

Publications: D. S. Yost, "NATO's Political-Military Challenges,"
                    Current History, vol. 81 (December 1982), pp. 401-404,
                    435-438.

                    D. S. Yost, "Ballistic Missile Defense and the
                    Atlantic Alliance," International Security, vol. 7
                    (Fall 1982), pp. 143-174.

                    D. S. Yost, "Arms Control Prospects at Madrid," World
                    Today, vol. 38 (October 1982), pp. 387-394.

                    D. S. Yost, "Maîtrise des armements et Conférence de
                    Madrid," Défense Nationale, vol. 38 (October 1982),
                    pp. 111-125.

                    D. S. Yost, "Rüstungskontrolle im KSZE-Prozess. Zum
                    Stand der Verhandlungen über ein Mandat fur eine
                    Konferenz über Abrüstung in Europa auf dem Madrider
                    Folgetreffen," Europa-Archiv, vol. 37 (September 25,
                    1982), pp. 545-552.

D. S. Yost, T. C. Glad, "West German Party Politics and Theater Nuclear Modernization Since 1977," _Armed Forces and Society_, vol. 8 (Summer 1982), pp. 525-560.

DEPARTMENT

OF

PHYSICS

DEPARTMENT OF PHYSICS

Research work in the department continued the trend toward interdiciplinary efforts and increased emphasis toward the establishment of centers of excellence. Our efforts have benefited from the presence of a number of visiting scientists, including the holder of the Chair of Applied Physics, a NSTEP selectee, several postdoctoral fellows, a visiting scientist from the Direction des Reserches, Etudes et Techniques (DRET) in France, and an increased number of research-sponsored high-level personnel. The optimism expressed last year for increased numbers of research personnel has become a fact.

New faculty are also starting or are soon to start having their impact on our programs. Dr. Steve Garrett joined us during the year and is already establishing a program of research in acoustical physics. Active recruiting is in progress for additional faculty in electro-optics and nuclear weapons effects, and new research is anticipated in these areas.

Some details of research initiatives follow on the next several pages, but highlights are worth noting here. We as a department continue the trend toward that sort of research which has to do with the interface between systems and the environment. Of particular note here are the activities of the Environmental Physics Group, our work in electro-optics, and work anticipated in the area of acoustic sensors. While applied work is a major effort in the department, very basic research is continuing. Theoretical work in the area of surface physics has received international recongnition; studies of exotic sources of radiation are continuing at out electron accelerator; and one of our faculty is spending a sabbatical in Europe to study the exciting developments in elementary particle theory and cosmology which may lead to a grand unification theory (GUT) of the forces of nature.

ACOUSTICS

Activity in the areas of acoustics and underwater acoustics was enhanced during 1982 by the presence of several visiting scientists. During the earlier part of the year, Prof. A. O. Williams, from Brown University, occupied the ONR-sponsored Chair in Underwater Acoustics. LCDR Francois Jouaillec, a French naval officer from the Direction des researches, Etudes et Techniques (DRET) spent a sabbatical year at NPS as a visiting scientist working in acoustics. Dr. Dominique Odero, a scientist working for a French firm, Sentra-Alcatel, arrived in September to spend about a year as a visiting scientist working with our acoustics faculty.

Professor H. Medwin has continued his work on scattering from rough surfaces. Jouaillec and Medwin collaborated on impulse

scattering from a cylindrically corrugated rough surface at grazing incidence.

Professors J. V. Sanders and A. B. Coppens are continuing their investigations on the propagation of acoustic waves from a fluid wedge into a sedimentary boundary. A facility for scale model experiments has been designed and is being constructed for a laboratory experiment to test theoretical models.

Professor O. B. Wilson, with help from students, has continued investigations of ambient acoustic noise in shallow water due to breaking surf. This work has been done in collaboration with the Naval Research Laboratory. They have found that, in Monterey Bay during heavy surf, significant contributions to low frequency noise levels arise from surf and that significant changes in directionality occur out to a water depth of over 200 m.

Professors Wilson and G. L. Sackman (Electrical Engineering Department) have continued their interaction with the Naval Undersea Warfare Engineering Station, Keyport, Washington, in an on-going, multi-disciplinary study of long-term technical and planning requirements of the Station, involving acoustics, signal processing, data analysis, and torpedo tracking.

A new acoustical physicist, Assistant Professor Steven L. Garrett, joined us in January and is building up his research laboratory. His research activities are primarily in the acoustic properties of liquid helium and in acoustic instrumentation.

ATOMIC PHYSICS

Professor Raymond Kelly has continued to operate the Spectroscopic Data Center with support from NASA. His compilation of spectroscopic data has continued to be an important source of data for researchers everywhere and is vitally important in the areas of space exploration and solar physics.

New work this year includes the publication of a critical compilation of spectral lines below 2000 A and updating and expansion of data already published.

It is expected that this work will be completed this year.

ELECTRO-OPTICS

Research concerning the optical properties of the atmosphere has continued with Professors Eugene C. Crittenden, Alfred W. Cooper, Edmund A. Milne, G. Wayne Rodeback, Sidney H. Kalmbach, and their students.

Work sponsored by the Naval Air Systems Command has investigated the effectiveness of the Compass Hammer system by computer simulation of its operation in a Naval engagement.

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An experimental program is also underway, sponsored by the joint Air Force-Navy Compass Hammer program, involving measurement of the turbulence optical properties of the atmosphere along optical paths from an aircraft to the ground. Theoretical work has also developed a model for the expected behavior. An unsponsored program is also in progress to verify the theoretical work under somewhat more ideal and controllable conditions in the laboratory.

Finally, a feasibility study of a designator spot wander determination system has been undertaken, under sponsorship of the Army Electronics Proving Ground, Fort Huachuca, New Mexico. These measurements should permit separation of the spot wander due to atmospheric effects from those due to platform and laser instability. Field tests are planned for this experiment in FY84.

Our electro-optics and environmental physics groups will continue their close interaction.

ENVIRONMENTAL PHYSICS

Professors Gordon Schacher of the Department of Physics and Ken Davidson of the Department of Meteorology have continued and expanded their efforts in directing the Environmental Physics Group at the NPS, with continuing efforts in marine atmospheric boundary layer modeling and model verification.

New work this year has included the modeling of atmospheric dispersion for studies connected with CBWD. Major overwater dispersion exeriments have been carried out and these unique data sets are being used to develop new model parameterizations. Cooperative efforts with the Army and Air Force are beginning.

The group is a major participant in an international study of the marginal ice zone (MIZEX), being responsible for shipboard and aircraft meteorological measurements. The area is one of critical concern for naval operations. This work will continue for a three-year period.

The group has continued to grow during the year, and is now a major center of excellence at the School, employing several research assistants and postdoctoral fellows and contract support personnel. The direction of research has tended more this year to air/sea interactions, which is an area of vital interest to the Navy in many respects. Considerable use has been made again of the Research SS Acania, including two experiments of two-week duration.

It is anticipated that the activities of the Environmental Physics Group will continue to expand during the next year and that the NPS will earn increased recognition as a prime source of quality research in this area.

EXPLOSIVE CHEMISTRY

Professors Richard Reinhardt and Gilbert Kinney have continued their work, sponsored by the Naval Weapons Center, China Lake, on the subject of chemical equilibria and overpressures resulting from the internal explosions of conventional and explosive fuels in the presence of reactive metals. This is a long-supported project of continuing benefit to the Laboratory and is expected to continue for some time.

GEOMAGNETIC PHENOMENA

The work of Professor Otto Heinz has continued this year, strengthened by the presence of Dr. Andrew Ochadlick (NSTEP program) and Dr. Michael Thomas (Postdoctoral fellow).

The work has continued to center around the phenomena of geomagnetic fluctuations on the ocean floor, and correlations with similar measurements at land-based sites.

Some new measurements this year have been quite interesting. Experiments conducted over 24-hour periods have revealed unexpected correlations in the polarizations of land and sea data. Further results regarding seawater conductivity (mentioned last year) have also been exciting and will lead to continued research.

LASER AND PLASMA PHYSICS

Activities in this area have remained centered on the connected topics of breakdown and unipolar arcing which occurs in laser metal-target interactions.

One experiment, carried on by Professor Fred R. Schwirzke with support from the Naval Research Laboratory, has been designed to determine the threshold value of laser irradiance for the onset of breakdown arcing, this arcing having been shown to be the primary damage mechanism when a plasma is formed in laser metal-target interactions. A model has been developed which predicts this phenomenon.

Related experiments, supported by the NPS Foundation Research Program, investigate unipolar arc damage of several materials, including stainless steel and TiC.

LINEAR ELECTRON ACCELERATOR

Work this year at the LINAC was concerned with investigation of Cerenkov and stimulated Cerenkov radiation from electrons. In the recent work, the radiation emitted by the bunched electron from the LINAC has been found to be a harmonics of the bunch frequency and not continuous, as in the usual Cerenkov case. Furthermore, it is coherent and is of greater magnitude than predicted by the usual theory. These discoveries suggest that this phenomenon may be useful

in beam monitoring for Free Electron Lasers, which remains a
difficult problem. Further work in this area is expected during the
coming year.

The LINAC research effort has been strengthened this year by the
return of Professor John Neighbours from his two-year tour at ONR
London. Further investigations, sponsored by ONR and in
collaboration with Stanford University, promise to produce
interesting results on the production of microwave energy by
interacting the electron beam with dielectric material.

SURFACE PHYSICS

The work of Professor Don E. Harrison, Jr., has continued to
bear fruit and gain international recognition during the year. He
and his postdoctoral fellow, Roger P. Webb, have enjoyed continued
support from the NSF, and the project now has support from ONR as
part of a SRO (Special Research Opportunity) for the next three
years.

The thrust of the research has been to establish the theoretical
background needed to validate and clarify experimental work using
Secondary Ion Mass Spectroscopy (SIMS). Professor Harrison has been
invited to present a paper at SIMS-IV (an International Conference)
on his work and other ion bombardment experimental techniques in
Japan this year.

Title:	Bismuth Germanate Gamma Detector Development
Investigator:	Fred R. Buskirk, Professor of Physics
Sponsor:	NPS Foundation Research Program
Objective:	This project was aimed toward improving the performance of Bismuth Germanate scintillation counters. An initial goal was to improve resolution, reasoning that poor resolution and low signal were caused by the high index of refraction of BGO relative to glass of the photomultiplier. Various treatments of the interface produced no improvement.

Summary:	One result which was observed was improved resolution of a broken crystal relative to the original. This improvement could be associated with non-uniformity of the original crystal, or with the diffuse internal reflection from the broken surface.

The most surprising and positive result concerned radiation resistance of BGO. One crystal was subjected to increasingly large bursts from the 100 MeV electron beam of the Linac. One NaI crystal cracked under this treatment but BGO functioned and emitted light during exposure. After exposure the only damage interfering with its performance was associated with activating the Bi and Ge.

This suggests that BGO has two new applications

(a) a gamma detector which is usable after a large blast.
(b) a beam monitor for electron beams in FEL or particle beam accelerators.

Theses Directed:	R. R. Cooke, "Scintillation Analysis of Gamma Radiation with Crystals of Bismuth Germanate", Master's Thesis, October 1982.

W. A. Fisher, "Instrumental Photon Activation Analysis Using the Linear Accelerator at the Naval Postgraduate School", Master's Thesis, October 1982.

Title:	Informal Progress Report on Cerenkov Electron Beam Monitor Project at the Naval Postgraduate School
Investigator:	Fred R. Buskirk, Professor of Physics
Sponsor:	Office of Naval Research
Objective:	To develop microwave Cerenkov radiation measurements as an electron beam monitor for the Linac.

Summary: Preliminary experiments relating to this project were started in Apr 1982 soon after funding was received. The present experiments measure the Cerenkov radiation produced when electrons are moving faster than the speed of radiation in a medium. In this case the medium is air and the radiation is at microwave frequencies (almost all reported Cerenkov work has been at optical frequencies).

The preliminary experiments indicate some dependence of the signal on the bunch length of the bunches of the electron beam from the Linac.

To be useful as an electron beam monitor for an FEL, the monitor should not degrade the electron beam. Thus dielectric slab detectors will be investigated later.

Thesis Directed:	L. J. Brown, "Stimulated Cerenkov Radiation Produced by 100 MeV Electrons", Master's Thesis, December 1981.

Title: Airborne Electro-Optical Countermeasures

Investigators: A. W. Cooper, Professor of Physics and E.
                   A. Milne, Associate Professor of Physics

Sponsor: Naval Air Systems Command

Objective: To participate in the mission analysis and
                   engineering development model phase of an
                   airborne electro-optic countermeasure
                   system by performance simulation using the
                   NPS-QUEST computer code. The work proposed
                   involved incorporation of up-to-date test
                   system parameters in the code, and analysis
                   of sensitivity of system performance to
                   variation of these parameters, in realistic
                   operational scenarios.

Summary: The simulation was performed in a variety
                   of suitable scenarios to determine the
                   sensitivity of the countermeasure time to
                   variation of search and acquisition emitted
                   energy density, receiver sensitivity, and
                   countermeasure system energy density, and
                   of target cross section and atmospheric
                   extinction coefficient. In addition the
                   effect of diffraction on the distribution
                   of energy in the Fresnel region as deduced
                   by computer analysis was compared with a
                   scaled experiment as a preliminary to
                   inclusion in the program. A qualitative
                   comparision of turbulence and diffraction
                   was also carried out.

Title: Ambient Noise and Array Characterization

Investigator: Alan B. Coppens, Associate Professor of
                    Physics

Sponsor: Naval Ocean Research and Development
                    Activity

Objective: To prepare a technical report giving a
                    tutorial introduction to the parabolic
                    approximation to the wave equation.

Summary: The derivation of the parabolic wave
                    equation for acoustic propagation is
                    studied and presented pedagogically for
                    tutorial purposes. The literature is
                    reviewed and modifications to the parabolic
                    equation to increase accuracy are
                    mentioned. Some of the algorithms for
                    computer implementation of the parabolic
                    approximation are discussed qualitatively,
                    and the various approaches to dealing
                    properly with the density change between
                    the water column and bottom are examined.

Title:	Studies in Shallow Water ASW Scenerios
Investigators:	Alan B. Coppens, Associate Professor of Physics
Sponsor:	Naval Research Laboratory
Objective:	To initiate a search of the classified literature for material pertinent to the special problems shallow water presents to tactical ASW situations.
Summary:	The literature search was initiated, the retrieved reports studied, irrelevant material identified, and relevant material indentified for detailed study.

STUDENTS MAKING COMPUTER-CONTROLLED ELEC-
TRICAL MEASUREMENTS ON A SONAR TRANSDUCER.

PHYSICS STUDENT CONSTRUCTING AND TESTING SONAR TRANSDUCER.

Title: Feasibility Study of Designator Spot Wander
                    Determination System

Investigators: E. C. Crittenden, Jr., E. A. Milne, and
                    G. W. Rodeback, Professors of Physics

Objectives: Study the feasibility for the determination
                    of designator spot wander by means of
                    measurements of the image-centered spot
                    profile during designator tests. The
                    measurements should permit separation of
                    the spot wander due to atmosphere from that
                    due to platform instability.

Summary: The necessary equipment has been procured
                    and set up for bench tests. Some of the
                    programs have been written for processing
                    the data. Further work is continuing on
                    program development for controlling the
                    equipment. Field tests are planned for
                    later in the year.

Title:　　　　　　Measurement of the Effects of Turbulence on Airborne Optical Projectors

Investigators:　　E. C. Crittenden, Jr., E. A. Milne , G. W. Rodeback, and S. H. Kalmbach, Professors of Physics

Sponsor:　　　　Pacific Missile Test Center

Objectives:　　　Measurement of $C_n{}^2$ for optical paths from an aircraft to ground during tests, at China Lake, of the Compass-Hammer device.

Summary:　　　Comparative measurements were carried out during several one week field experiments at China Lake. $C_n{}^2$ (the turbulence structure constant for optical index fluctuation) was measured both by means of MTF (Optical resolution as expressed by means of Modulation Transfer Function) and by means of scintillation. Comparison of these results and with results obtained by another group (Pacific Sierra Research) made it apparent that direct measurement of intensity fluctuation should be carried out for these experiments. As a result two more field experiments were carried out with new equipment, utilizing GaAs laser sources on the aircraft tracked to the ground receiving station.

Title: Analysis of Ray-Tracing Algorithms for
                    Underwater Acoustic Ranges

Investigator: Harvey A. Dahl, Assistant Professor of
                    Physics

Sponsor: Naval Undersea Warfare Engineering Station
                    (NUWES)

Objective: To analyze further the relative merits of
                    competing algorithms used to locate sound
                    sources in underwater acoustic ranges.

Summary: Certain features of the ray-tracing
                    algorithms for locating a target that were
                    developed at NPS in a previous year have
                    not yet been incorporated into the NUWES
                    range computer software system. In
                    particular, the improved NPS algorithms
                    that trace the ray from the array to the
                    target beginning with a given angle of
                    elevation and azimuth still need to be
                    applied.

                    The present effort has attempted to
                    demonstrate quantitatively the increase in
                    accuracy that would result if NPS
                    algorithms were used. In order to obtain a
                    measure of the precision of the ranging
                    calculations, it was necessary to calculate
                    accurate travel times of the signal from
                    the sound source to each of the four array
                    hydrophones for various sound speed
                    profiles that exist on the acoustic range.
                    Algorithms for determination of angle of
                    arrival at an arbitrarily tilted array and
                    for ray trace-back utilized the calculated
                    travel times and determined the predicted
                    target position. The magnitude of any
                    discrepancies between this predicted
                    position and the known true target position
                    depend on the accuracy of the algorithms
                    and the precision of the calculated travel
                    times. Comparison between the true target
                    position and the predicted position have
                    now been made for a wide range of
                    conditions.

Title: Laboratory "Start-up" Grant

Investigator: S. L. Garrett, Assistant Professor of
                     Physics

Sponsor: NPS Foundation Research Program

Objective: To plan and equip a modern laboratory facility
                     for research in acoustics by obtaining necessary
                     instrumentation and computers.

Summary: Over 51K$ was spent to equip three laboratories
                     with the most advanced general laboratory
                     instrumentation and automated data acquisition
                     and analysis systems. To augment the NPS
                     Foundation Research Program funding, research
                     proposals were written and submitted to: (1)ONR
                     for research in physical acoustics (funded 7
                     June 82), (2) NPS Foundation for Postdoctoral
                     support (approved 16 June 82), (3) Research
                     Corporation for support of low temperature
                     acoustics (pending), and (4) N.S.F. for low
                     temperature acoustics (pending).

Theses Directed: D. Conte, "Computer Controlled Acquisition and
                     Analysis of Sound Resonance Measurements",
                     Master's Thesis, December 1982.

                     L. Skorenek, "Automated Measurement of SONAR
                     Transducer Equivalent Electrical Parameters",
                     Master's Thesis, December 1982.

Title: Reciprocity Calibration in Unconventional
                    Geometries (Phase I)

Investigators: S. L. Garrett, Assistant Professor of
                    Physics

Sponsor: Office of Naval Research

Objective: This project covers the first phase of a
                    program disigned to test extensions of the
                    reciprocity method for absolute calibration
                    of electroacoustic transducers beyond the
                    traditional geometries. The first
                    experiments will test both internal
                    self-consistancy and absolute accuracy of
                    the method applied to plane wave resonators
                    and travelling wave tubes.

Summary: At present, the initial contract has only
                    been in operation for three months. During
                    that time most of the equipment necessary
                    for instrumentation, computer control, and
                    the microphone translator has been ordered
                    in anticipation of 1 Oct. 1982, when the
                    contract will permit me to devote full time
                    to this project. Substantial progress has
                    already been made in the development of a
                    computer controlled system which will
                    acquire and process the electrical and
                    acoustical signals for the reciprocity
                    measurements. This system will measure and
                    track resonance amplitudes, center
                    frequencies, and quality factors
                    automatically with far greater precision
                    and reproducibility than possible with
                    ordinary manual measurement procedures.

Conference
Presentation: D. Conte, and S. Garrett, "Computerized
                    Measurement and Tracking of Acoustical
                    Resonances", Journal of Acoustical Society
                    of America, 72, S82 (1982).

Title:	Classical Trajectory Studies of Low Energy Ion Impact Mechanisms on Clean and Reacted Single Crystal Surfaces
Investigators:	Don E. Harrison, Jr., Professor of Physics, with Roger P. Webb, Postdoctoral Associate
Sponsor:	National Science Foundation and NPS Foundation Research Program
Objectives:	Continue study of the effects produced when ions bombard clean and chemically reacted single crystal metal surfaces to understand mechanisms and coordinate with experimental investigations.

Summary:

Classical trajectory simulations have developed to the point that it is feasible to model the cascade produced by an ion impact event. The ability to follow each individual atom in the cascade leads naturally to pictorial interpretations of a single sputtering event. Statistical analysis of data produces numbers which can be directly compared to the experimental data. The model computations are done using single crystal targets oriented to expose the low index surfaces. Research effort this year has establised that low keV ion bombardment produces pits in metal surfaces, indicating that there is no essential difference between the linear cascade and high energy density regimes of statistical sputtering theory. Very low energy sputtering has been studied and the lowest energy sputtering mechanisms identified. A new version of the program has been developed whose run time increases as N, the number of atoms in the target, rather than N^2 as in the past. A program has been written to study pit formation and ion beam mixing. Another program has been written to study very low energy ion scattering. The work will be done in conjunction with investigators from SRI and the FOM Laboratory in Amsterdam. Studies of displacement from propagation were completed.

Publications: R. P. Webb and D. E. Harrison, Jr.,
                       "Near-Threshold Sputtering Mechanisms from a
                       Computer Simulation of Argon Bombarded Clean
                       and Oxygen-Reacted Copper Single Crystals,"
                       Journal of Applied Physics, 53(7), 5243, 1982.

                       D. E. Harrison, Jr. and R. P. Webb, "A Molecular
                       Dynamics Simulation Study of the Influence of the
                       Lattice Atom Potential Function Upon Atom
                       Ejection Processes," Journal of Applied Physics,
                       53(6), 4193, 1982.
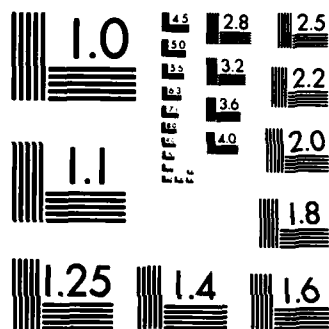
MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Title:	Geomagnetic Field Fluctuations on the Ocean Floor
Investigators:	O. Heinz, Professor of Physics, P. H. Moose, Associate Professor of Electrical Engineering, Dr. Michael Thomas, Postdoctoral Fellow
Sponsor:	Office of Naval Research
Objective:	The objective of this project is to obtain improved long term data and interpretations of the electromagnetic noise, particularly its spectral composition, spatial and temporal coherence and state of polarization.
Summary:	Measurements of geomagnetic field fluctuations in the .01 to 10 Hz frequency range were carried out on the sea floor and on land using multicomponent coil magneto-meters. Data telemetry links allowed simultaneous recordings of PCM encoded data over 24 hour periods. Comparison of observed power spectral densities shows agreement with a simple model of the micropulsation field. The polarization characteristics of the observed field were analyzed in terms of Stokes parameters.
Theses Directed:	M. P. Ames and L. M. Vehslage "Low Frequency Geomagnetic Flucations (.025 to 20 Hz) on the Floor of Monterey Bay," Master's Thesis, December 1981.

J. Schweiger "Evaluation of Geomagnetic Activity in MAD Frequency Band (.04 - .6 Hz)," Master's Thesis, September 1982. |

STUDENTS ASSEMBLING OCEAN FLOOR MAGNETIC
SENSOR PACKAGE.

Title:	Spectroscopic Data Center Compilations of Near Ultraviolet Spectra
Investigator:	Raymond L. Kelly, Professor of Physics
Sponsor:	National Aeronautics and Space Administration
Objective:	To produce a critical compilation of long wavelength ultraviolet lines (wavelengths 2000-3000 Angstroms) in support of space exploration and solar physics, maintaining a current compilation on continuous basis. The work is based on publications in the open literature.
Summary:	The initial compilation of 30,000 lines, from the first 36 elements, has been completed. It has been stored on magnetic tape and published as a NASA Special Publication. Work has started on adding the classifications to each line as an extension of the initial compilation. This continuing project will be completed in three years. Included in the final compilation will be (for each spectrum line) wavelength, intensity, classification, and energy level for both the upper and lower state in the transition.
Publication:	R. L. Kelly, "Atomic Emission Lines in the Near Ultraviolet; Hydrogen Through Krypton," NASA Technical Memorandum 80268, (April 1979).

Title: Spectroscopic Data Center Compilations of
                    Vacuum Ultraviolet Spectra

Investigator: Raymond L. Kelly, Professor of Physics

Sponsor: Office of Standard Reference Data, National
                    Bureau of Standards

Objective: Preparation of a critical compilation of
                    atomic spectrum lines with wavelengths
                    below 2000 Angstroms, for the first 36
                    elements. This is a continuing project.

Summary: Computer-based files are prepared
                    containing the wavelength, intensity, and
                    classification for all lines observed in
                    solar or terrestrial sources. A complete
                    file of atomic energy levels is maintained
                    for calculation of wavelengths of predicted
                    transitions. These wavelengths are
                    critically compared with those reported in
                    the literature and in unpublished
                    communications. A new compilation has been
                    completed for the first 18 elements and
                    stored on magnetic tape, and submitted for
                    publication. Completion of the final
                    compilation is scheduled for 1983.

Title: Internal Explosions with Reactive Metal
Present

Investigators: R. A. Reinhardt, Professor of Chemistry,
and G. F. Kinney, Distinguished Professor
of Chemistry Emeritus

Sponsor: Naval Weapons Center

Objective: Continuation research into the
physico-chemical behavior of confined
explosions of reactive metals with fuels in
air.

Summary: A model has been developed to account for
the temperature-composition diagram in the
liquid-solid system Al_2O_3 - MgO, taking
into account the formation of the compound
$MgAl_2O_4$ and the existence of two solid
solutions of limited range. The liquid was
assumed to be an ideal solution with the
MgO dissolving undissociated, but with
$MgAl_2O_4$ and Al_2O_3 dissolving to
form ions. The solid phases must be
treated as non-ideal, in order to account
for the discontinuity of solutions. This
model has then been used to estimate
various thermochemical and thermodynamic
properties needed for the calculations on
internal explosions in which both magnesium
and aluminum metals are present.

Publications: R. A. Reinhardt and A. K. McDonald, "Adia-
batic Computation of Internal Blast for
Aluminum-cased Charges in Air", Naval
Weapons Center Technical Report, NWC
TP6287, Jan., 1982.

R. A. Reinhardt, "A Working Model for the
System Alumina-Magnesia", Naval Weapons
Center Technical Memo, in progress.

Thesis Directed: Lewis K. Athow, "Real Gas Considerations
for Determining Physical and Thermodynamic
Properties of Gases Involved in the
Prediction of the Effects of Internal
Explosions," Master's Thesis, June 1982.

Title: Coastal Diffusion Experiments

Investigators: G. E. Schacher, Professor of Physics, and
                    K. L. Davidson, Professor of Meteorology

Sponsor: Department of the Interior

Objective: Obtain tracer and meteorological data to
                    parameterize a diffusion model to predict
                    onshore impact of the release of pollutants
                    into the atmosphere from the outer
                    continental shelf region.

Summary: Two series of experiments have been carried
                    out in the Pismo Beach, CA area, during
                    December 1981 and June 1982. The two time
                    periods were used so that Summer and Winter
                    conditions would be tested. The tracer gas
                    SF_6 was released continuously from the
                    RV/Acania and traced by Stanford Research
                    International. NPS gathered meteorological
                    data from the ship to characterize the
                    marine boundary layer. All data has been
                    analyzed to produce the mean meteorological
                    properties, the fluxes of heat, momentum,
                    and water vapor and the wind variance.

Publications: G. E. Schacher, D. E. Spiel, and C. H.
                    Leonard, "Offshore Transport and Dispersion
                    in the California Coastal Region - BLM III,
                    NPS Data Summary" NPS Technical Report,
                    NPS61-82-004TR, 1982.

                    G. E. Scahacer, D. E. Spiel, C. W. Fairall,
                    K. L. Davidson, C. A. Leonar, and C. H.
                    Reheis, "California Coastal Offshore
                    Transport and Diffusion Experiments -
                    Meteorological Conditions and Data"
                    NPS Technical Report, NPS61-82-007TR,
                    1982.

Title: Comparison of Puff and Gaussian Diffusion
                    Models for Short Term Releases.

Investigators: G. E. Schacher, Professor of Physics, and
                    K. L. Davidson, Professor of Meteorology

Sponsor: Naval Surface Weapons Center

Objective: Run the NPS/Riso puff model on
                    meteorological data supplied by NSWC and
                    supply the results to NSWC for comparison
                    with Gaussian model results.

Summary: Mean meteorological parameters determined
                    by NSWC, and used for their Gaussian
                    modeling, have been obtained. These data
                    have been used as inputs for the puff model
                    to obtain model predicted plume behavior.
                    Results from these model runs have been
                    delivered to the sponsor. Tapes of the
                    original meteorological data have been
                    obtained and are being averaged over
                    different time periods to produce data for
                    additional model runs.

Title: Overwater Diffusion in the Coastal Zone

Investigator: G. E. Schacher, Professor of Physics

Sponsor: Office of Naval Research, Naval Surface Weapons
                    Center, Dahlgren

Objective: Augment existing diffusion experiments
                    by gathering more extensive overwater and
                    shoreline data using continuous gas
                    analyzers in an aircraft and a truck.

Summary: The experiment was carried out in June,
                    1982 in the Pismo Beach, CA area. Energy
                    Resources Co. supplied and operated continuous
                    SF_6 analyses in an aircraft and a truck.
                    Seven experiments of approximately five hours
                    duration each were carried out. The overwater
                    plume was transected at several distances
                    between the RV/Acania release point and the
                    shore, several times each hour. The data is
                    being analyzed to produce both short-term
                    and long-term average plume cross sections.

Title:	Impurities in Tokamaks
Investigators:	F. Schwirzke, Professor of Physics and R. J. Taylor, Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles
Sponsor:	Research at UCLA supported by the Department of Energy
Objective:	In this project the impurity release by plasma surface interactions is studied.

Summary: Impurities released by plasma-surface interactions play a major role in influencing the performance characteristics of many of today's magnetic fusion machines, especially tokamaks. Loosely bound metal atoms are probably contributing to the observed, higher than expected, high-Z impurity concentrations in tokamaks. Knowledge of the surface conditions during tokamak discharges is most important for a better understanding of processes related to plasma-surface interactions, discharge cleaning, and impurity transport.

Surface analytic techniques like auger spectroscopy, SEM and energy electron diffraction have been used to measure after many discharges the integrated accumulation of impurities on titanium coated surfaces. The resiliency of metals and protective coatings to plasma contact and unipolar arcing has been studied.

Publications: L. Keller, C. N. J. Wagner, F. Schwirzke and R. J. Taylor, "Analysis of Titanium Coatings Deposited and Exposed in Macrotor and Microtor", Journal of Nuclear Materials, 107, (1982) 104-115.

L. Oren, L. Keller, F. Schwirzke, S. Talmadge, and R. J. Taylor, "Influence Exerted by the Plasma Edge Pontential on Recycling, Sputtering, and Impurity Accumulation", Journal of Nuclear Materials, 111 & 112 (1982).

L. Keller, R. F. Bunshah, L. Oren, F. Schwirzke, R. J. Taylor and C . N. J. Wagner, "Structure and Effective Impurity Control of Various Metallic Coatings in Macrotor", Journal of Nuclear Materials, 111 & 112 (1982).

F. Schwirzke, L. Keller, L. Oren, and R.J. Taylor, "Behavior of Hot Titanium Getters at the Plasma Edge in Tokamaks", Journal of Nuclear Materials, 111 & 112 (1982).

Conference
Presentations: F. Schwirzke, "Behavior of Hot Titanium Getters at the Plasma Edge in Tokamaks", Fifth International Conference on Plasma Surface Interactions in Controlled Fusion Devices, Gatlinburg, Tennessee, May 3-7, 1982.

L. Keller, L. Oren, H. S. Rhandhawa, R. J. Taylor C. N. J. Wagner, R. F. Bunshah, and F. Schwirzke, "Behavior of Hot Walls at the Plasma Edge," 23rd Annual Meeting of the Division of Plasma Physics of the American Physical Society, New York, N.Y. 12-16 October 1981.

Title:	Plasma-Mediated Thermal Response of Various Laser-Targets
Investigator:	F. Schwirzke, Professor of Physics
Sponsor:	Naval Research Laboratory
Objective:	To determine the enhanced energy coupling from a laser heated plasma into a target when unipolar arcing occurs.

Summary:

Unipolar arcing has been shown to be the primary damage mechanism when a plasma is formed in laser metal-target interaction. About 300,000 to 500,000 arc craters per cm^2 have been observed on laser illuminated metal surfaces although no external voltage is applied. Cratering was observed even with a defocused laser. The minimum laser power density required for the onset of breakdown on the surface is also sufficient to cause arc damage. Once breakdown occurs, arcing also occurs. Never was there a plasma evident without attendant unipolar arcs.

Unipolar arcing concentrates the available laser-plasma energy towards the cathode spots. Metal erosion is much more severe than for homogeneous energy deposition. Our model shows that the local increase of the plasma pressure above the cathode spot leads to an increased electric field to drive the arc current. This research has wide spread applications. In any situation in which a plasma exists there will be plasma surface interactions. The physics relates to other forms of electrical breakdown on surfaces and electrodes.

Theses Directed:	**M. H. Beelby and H. A. Ulrich**, "A Study of the Breakdown Mechanism of AISI 304 Stainless Steel, AISI 2024 Aluminum and Various Titanium Coatings", <u>Master's Thesis</u>, December 1981.
	R. M. Metheny, "An Investigation of Energy Coupling in Various Arc Susceptible and Resistant Conductors", <u>Master's Thesis</u>, June 1982.
Conference Presentations:	
	F. Schwirzke, "Unipolar Arc Model", 23rd Annual Meeting of the Division of Plasma Physics of the American Physical Society, New York, N.Y. 12-16 October 1981.
	F. Schwirzke and H. G. Ulrich, "Laser Induced Unipolar Arcing", 1982 IEEE International Conference on Plasma Science, Ottawa, Canada, May 17-19, 1982.

Title: Range Studies Program

Investigators: O. B. Wilson, Jr., Professor of Physics,
                    G. L. Sackman, Professor of Electrical
                    Engineering

Sponsor: Naval Undersea Warfare Engineering

Objective: Study long term requirements and plans of
                    the Naval Undersea Warfare Engineering
                    Station in areas of ship and underwater
                    weapons testing and, based on changing
                    technology and changing operational needs of
                    the Navy, recommend changes on upgrading or
                    replacing equipment, modifications of
                    procedures and development of new testing
                    concepts.

Summary: About ten Faculty members from several
                    disciplines and some of their students have
                    worked on a number of different projects.
                    Individual summaries appear elsewhere in
                    this document. A very brief summary of
                    project activity follows. Work has been
                    accomplished on adapting Kalman Filtering
                    methods to improve the real-time estimates
                    of torpedo position and depth on the
                    3-dimensional tracking ranges at NUWES
                    Keyport. Theory and computational
                    procedures have been developed for post-run
                    smoothing of torpedo track data and for the
                    analysis of data from such procedures.
                    Studies have been made of the relations
                    between calibration of a ship's ASROC weapon
                    system and performance of that ship during
                    SHAREM exercises. Experiments have been
                    conducted with acoustic parametric arrays to
                    provide design data for an acoustic imaging
                    system which could assist in recovery of
                    torpedoes buried in sediment. Developments
                    have been made in the application of
                    fiber-optic techniques for transmission of
                    data used in Keyport's tracking ranges.
                    Analysis has been conducted on the effects
                    of surface reverberation on acoustic
                    propagation in Dabob Bay. Studies have been

relating to applications of reliability
analysis to Keyport's weapons range support
systems. A study was made of the potential
applications of robotics techology and
alternate energy systems to operations at
Keyport. A design study was begun concerned
with the use of steerable acoustic arrays in
radiated noise measurements.

Publication: O. B. Wilson, "Annual Summary Report of Range
Studies Program", NPS Project Report, NPS61-83-
001PR, October 1982.

Title: Research on Ambient Acoustic Noise in
                  Shallow Water

Investigators: O. B. Wilson, Jr., Professor of Physics,

Sponsor: Naval Research Laboratory

Objective: To analyze and prepare for publication
                  ambient noise data previously collected in
                  Monterey Bay.

Summary: The work of preparing a technical report
                  on previously collected data will be
                  completed by December 1982. Additional
                  analysis has resulted in the values of
                  absolute sound pressure levels for various
                  ranges from shore and various surf
                  conditions. Sony data processing equipment
                  obtained and is being modified for
                  laboratory use.

Conference
Presentation: O. B. Wilson (with S. N. Wolf), "Measure-
                  ments of Horizontal Anisotropy of Shallow
                  Water Due to Breaking Surf," Meeting of
                  Acoustical Society of America, Miami
                  November 1981.

Theses Directed: M. J. Gagliardi, "Measurements of Horizon-
                  tal Directionality of the Ambient Sea Noise
                  in Monterey Bay, California," Master's
                  Thesis, March 1982.

                  C. Elles, "Data Analysis of Acoustic
                  Ambient Noise in Monterey Bay California,"
                  Master's Thesis, in Progress.

DEPARTMENT

OF

ELECTRICAL ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

The Research Program of the Electrical Engineering Department involves projects in the following areas: signal processing; electromagnetics, microwaves and antennas; communications; radar and electronic warfare; computer engineering; command, control, communications and intelligence (C^3I) systems; and electro-optics and fiber optics. Summaries of the current research projects follow.

SIGNAL PROCESSING

Image data compression using B-spline functions is being investigated by Professor Chin-Hwa Lee. The goal of the project is to use cubic B-spline basis functions to provide smooth interpolation from unevenly-spaced samples of image data thereby allowing the development of a fast algorithm for image reconstruction that is suitable for VLSI implementation. Such an algorithm would have significant benefits for interactive graphics, real-time image simulation and generation for combat trainer and image data compression.

Professor Sydney Parker developed a technique for the optimal design of FIR digital filters with finite coefficients using a Least Mean Square (LMS) criterion. He is also investigating the use of lattice parameter techniques for the modeling of linear circuits and systems for purposes of performance evaluation and fault detection. Additionally, Professor Parker is studying the modeling of nonlinear systems using digital signal processing techniques and is investigating two-dimensional signal modeling with lattice parameters.

Professor John Powers has been working in the area of computer-aided acoustic imaging for non-destructive testing, or underwater viewing applications. In the past years his work has centered on converting the acoustical imaging data acquisition system from hardwire control to microprocessor control and in development of software for data handling.

Professor Lonnie A. Wilson's project on Infra-Red (IR) Ship Target Classification investigated the potential of several classification algorithms using IR. The signal processing and classification algorithms are compatible with conventional FLIR's and Focal Plan Array FLIR systems.

Adjunct Professor Klaus Holla is investigating image processing and pattern recognition of real world color pictures in projects involving modeling the human visual system to preprocess color video signals, chrominance as a 2-dimensional feature for image segmentation and segmentation of color video signals using luminance, chrominance and local dependences.

ELECTROMAGNETICS AND MICROWAVES AND ANTENNAS

Professor Gray continued his work on Shipboard RFI measurements at Microwave/Millimeter Wave frequencies. Five shipboard measurement trips were made as well as a study of RFI from shipboard aircraft/missile systems.

Professor Jeffrey Knorr has upgraded the Microwave Network Analyzer to a fully automatic, computer controlled system and developed a state-of-the-art Scalar Analyzer System for the 60-90 GHZ band. The uses of this network measurement system includes the accurate characterization of microwave and millimeter wave devices and components, antenna pattern measurement and the measurement of radar target cross-section.

Professor Knorr's work on the effects of emitter antenna characteristics on the intercept probability of a collection system continues. A model for estimating intercept probability from system performance data has been developed and gain statistics of various antennas have been investigated.

Investigations of fluctuations of geomagnetic fields are being continued by Professors Paul Moose and Otto Heinz (PHYSICS). Digital telemetry links from a spar-bouy connected to the sea floor sensors were installed. The sea-floor sensor has been connected to the spar bouy by a fiber optic link designed and constructed by two of Professor Powers' students. Data reduction is concentrating on production of power spectral densities. However, preliminary analysis of the geomagnetic fields' polarization properties indicates this may be a fruitful area for further research.

Professors Yi-Chi Shih and Kenneth Gray collaborated on examining the complex-power conversion technique for the study of bandpass filter structures in finlines. This technique was found to be equivalent to a mode-matching method. The relative convergence phenomenon asociated with this method was studied for a step-type discontinuity.

COMMUNICATIONS

A satellite earth station receiver in the 3.7-4.2 GHz band was installed under the supervision of Professor Jeffrey Knorr. This installation is being used in laboratory exercises designed to illustrate principles of satellite communications.

In collaboration with investigators outside NPS, Professor Glen Myers has measured performance of a delay-lock tracking loop where noise power exceeded signal power. Work included design, construction, operating and testing of a conventional delay-lock tracking loop. Professor Myers has also measured performance of: an asynchonous receiver used to recover binary data when the carrier is noise; a simple integrated circuit used to generate arbitrary composite amplitude and phase-shift keyed sinusoidal couplers; and of a communications system using frequency hopping to provide improved ECCM.

Experimental investigations of dynamic routing and control algorithms for distributed packet radio networks are being conducted by Professor John Wozencraft. The method of analysis involves the simulation of moderate sized networks using the Simscript computer language.

Adjunct Professor Daniel Bukofzer conducted analysis of a receiver in the presence of noise and an intentional interference signal and examined detection of a periodic signal with random phase in additive noise under low SNR conditions. The goal is to analyze the vulnerability of receivers to jamming, and find ways (i.e. design optimum receivers) that are able to operate in the presence of a jammer. Results have been obtained for standard modulation devices, such as PSK and FSK, by evaluating receiver probability of error in the presence of various jamming strategies.

RADAR AND ELECTRONIC WARFARE

Professor Michael Morgan continued his investigations into Natural Resonance Radar Target ID sponsored by ONR and in Radar Cross Sections via Transient Measurements under DARPA sponsorship. Investigations have established a scattering range with the exception of the computer controlled target platform. Fidelity of measurements and deconvolution algorithms for impulse response construction are currently being evaluated using targets whose characteristics can be computed.

Professors Harold Titus and Alex Gerba have worked on development of Kalman filtering and smoothing of target tracking of actual range data for the Naval Torpedo Station Research and Engineering Department in Keyport, Washington. An algorithm was developed to smooth all past filtered estimates and simulated torpedo test runs demonstrated that smoothed estimates of states were better than or equal to the filtered estimates. The Extended Kalman Filter and the Optimal Smoothing Estimator were applied to actual torpedo run data with limited success and work is continuing in the effort to fully implement the program for installation on the tracking range computer.

Professor Donald Stentz under the sponsorship of the Naval Undersea Warfare Engineering Station at Keyport, Washington, has investigated the readiness of the surface fleet to perform a screening mission, and ultimately deliver a rocket thrown torpedo launched by destroyers (ASROC) within striking distance of the target. The goal was to correlate data from Fleet Operation Readiness Accuracy Check Sites (FORACS), and Ship ASW Readiness/Effectiveness Measuring Program (SHAREN) exercises to determine whether the weapon systems on the fifty-six ships involved were within acceptable calibration limits at the time of the exercise and should have been expected to detect, locate and place a weapon within striking distance of the target.

Professor Stentz has also been investigating the Mobile Acoustic Tracking Range (MATR) proposed by NUSC. The goal is to investigate current and near future technology in various fields and disciplines to see if it will be useful when applied to the proposed tracking range.

Professor Lonnie A. Wilson's continuing project on Automatic Radar Ship Classification for Cruise Missiles has developed several new ship target classification algorithms. The algorithms have been successfully tested on a small number of ship targets.

Adjunct Professor Stephen Jauregui's work to categorize type and level of noise and interference at communication sites continues. Sources of the noise have been identified and specific instruments identified.

Adjunct Professor Jauregui also performed a tradeoff investigation of available or near term available receiver types in the VHF range for SIGINT application. At this point, only the investigation of various receivers has been completed. The investigation will be continued this year.

COMPUTER ENGINEERING

Professor Chin-Hwa Lee has initiated a program for computer region segmentation on aerial photographs. The objective is to improve the performance of existing algorithms on region segmentation techniques. A recursive splitting method at hierarchical scopic levels will be developed and implemented.

Professors Rudolf Panholzer and Mitchell Cotton, with Professor Uno Kodres of the Computer Science Department, are continuing their involvement in sponsored AEGIS System research. They are involved in computer architectural research oriented to application of multiple microcomputers to real-time tactical data processing and weapons control.

Professor Tien Tao is investigating processing architectures for advanced warning systems in a joint USAF/DARPA program to develop advanced technologies required to support the development of next generation space surveillance systems providing long range early warning of ballistic missile attack.

Professor Herschel Loomis initiated a project on Search Algorithms and Architectures to create at NPS a secure, digital state-of-the-art facility where research into Signals Intelligence (SIGINT) problems can be conducted. Professor Loomis also initiated a program on Tactical Information Systems to develop hardware architectures and software techniques to support the delivery of timely, accurate tactical data. Professor Loomis's work continued on the design of high speed recursive digital filters using pipeline techniques and on Computer Aided Design (CAD) of microprocessor based systems. Recent work has developed stability criteria for the high speed filter realization. Work is continuing on appropriate VLSI modules for realization of 100 MHz sample rate filters. Work continues on the microprocessor based system with Professor Ross of Computer Science.

COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE (C^3I) SYSTEMS

Professors Moose and Kai E. Woehler (PHYSICS) continued their studies on Cybernetic Models of Military C^3I Systems. A four-species model for modern military combat has been developed. This model uses non-linear state equations to describe the dynamic interactions between information, command and control, and combat force effectiveness. Computer simulations have helped discover useful properties of this model.

Professor Wilson initiated a project on Multi-Source Track Management (MSTM). The objective is to provide theoretical analysis and system tradeoff for the MSTM function of the Advanced Combat Direction Systems (ACDS) which requires a fully developed sensor and C^3I ability.

ELECTRO-OPTICS AND FIBER-OPTICS

Professor Powers continues two projects in these areas. One involves development of a laser excited fibre optic data-link between a helicopter instrumentation pod and a receiver mounted at a fuselage window. The link was designed and successfully tested. The other project is an investigation of fiber optic communications for suitability in underwater range applications. A successful underwater data link has been designed and tested.

Title: Shipboard RFI Measurements at Microwave/Millimeter
                        Wave Frequencies

Investigator: K. G. Gray, Associate Professor of Electrical
                        Engineering

Sponsor: Naval Electronic Systems Command

Objective: To characterize the RFI environment aboard U.S. Navy
                        ships in support of the Navy EHF Satellite Program.

Summary: The measurement program included 5 shipboard measure-
                        ment trips and a study of RFI from shipboard air-
                        craft/missile systems.

Title:	Noise and Interference at Communication Sites
Investigator:	Stephen Jauregui, Jr., Adjunct Professor of Electrical Engineering
Sponsor:	Naval Electronics System Command
Objective:	To categorize type and level of noise and interference at selected communications sites.

Summary: This is a continuation of work accomplished over the past five years. Sources have been defined as coming from afar, nearby, system caused in the signal chain and system caused external to the signals chain. Modernization encompassing solid state switching techniques, computer power supplied computer clocks as well as having insufficient dynamic range have been identified as principal culprits in the problem.

Title: Numerical Modeling of Microwave Reflector Antenna
                       Systems

Investigator: Stephen Jauregui, Jr., Adjunct Professor of
                       Electrical Engineering

Sponsor: Voice of America

Objective: Develop numerical models of military communication
                       reflector antennas.

Summary: The QRC-1 and commercial Andrew HP series antennas
                       were modeled using the NEC/REFLECTOR code. The
                       numerical models developed were used to calculate
                       back and side lobe structures for use in EMC
                       siting studies.

Title: Numerical Modeling Technology Transfer

Investigator: Stephen Jauregui, Jr., Adjunct Professor of
                      Electrical Engineering

Sponsor: U.S. Army Communications Electronics Engineering
                      Installation Agency and Naval Ocean Systems Center

Objective: Summarize and present current modeling techniques
                      developed for wire antennas and reflector systems.

Summary: A workshop presentation was held at Ft. Huachuca
                      during which modeling guidelines developed during
                      the past 10 years at NPS were described to and
                      exercised by Army personnel.

Title: Quasi-Static Numerical Modeling Antenna Study

Investigator: Stephen Jauregui, Jr., Adjunct Professor of
                    Electrical Engineering

Sponsor: Naval Ocean Systems Center

Objective: Develop a version of the Numerical Electromagnetics
                    Code capable of quasi-static antenna analysis and
                    model a typical VLF antenna.

Summary: A quasi-static version of NEC was developed on site
                    at NOSC and was used to model the Cutler VLF antenna.

Title: VHF SIGINT Receivers

Investigator: Stephen Jauregui, Jr., Adjunct Professor of
                      Electrical Engineering

Sponsor: Naval Electronics System Command

Objective: To do a tradeoff investigation of available or near
                      term available receiver types in the VHF range for
                      SIGINT applications.

Summary: VHF receiver types for SIGINT applications were in-
                      vestigated to determine the optimal use for various
                      facets of SIGINT. Receivers investigated were
                      compressive, channelized, (both with and without the
                      Bragg Cell technique) as well as standard super-
                      heterodyne. Auxillary equipment such as pre-
                      amplifiers, RF filters, multicouplers were also in-
                      vestigated.

Thesis Directed: Michael J. Loucks, "VHF SIGINT Receivers", Master's
                      Thesis, September 1982.

Title: Collection System Performance Optimization Study

Investigator: Jeffrey B. Knorr, Professor of Electrical Engineering

Sponsor: Office of Naval Research

Objective: To determine the effects of emitter antenna charac-
teristics on the intercept probability of a col-
lection system.

Summary: A model for estimating intercept probability from
system performance data has been developed. The gain
statistics of various antennas have been investi-
gated.

Publication: J. B. Knorr, "A Radiowave Receiving System Intercept
Probability Model", IEEE Transactions on Aerospace
and Electronic Systems, November 1982.

Theses Directed: Michael Scagnelli, "Computer Modeling of Reflector
Antenna For Field Sidelobe Levels", Master's Thesis,
December 1982.

                      Walter Varakin, "An Investigation of Antenna Gain
Statistics", Master's Thesis, September 1982.

Title:	Elevated Duct Propagation Prediction
Investigator:	Jeffrey B. Knorr, Professor of Electrical Engineering
Sponsor:	Department of Defense
Objective:	To develop simple models and practical methods for predicting the power density of signals guided by elevated tropospheric ducts.
Summary:	A simple deterministic model has been developed along with a methodology for computing the long term power distribution of ducted signals. Work is continuing to refine the model and to further investigate the joint probability for elevated duct parameters.
Publications:	J. B. Knorr, "A Simple Model for the Computation of Height-Gain in the Presence of Elevated Tropospheric Ducts", NPS Technical Report, NPS-62-82-045TR, September 1982. J. B. Knorr, "Methodology for the Computation of the Power Distribution of Signals Propagated Through Elevated Tropospheric Ducts", NPS Technical Report, NPS-62-82-044TR, September 1982.
Theses Directed:	Robert Yelverton, "MINIDUCT: A Microcomputer Based Elevated Duct Circuit Code", Master's Thesis, September 1982. David Petke, "A Numerical Investigation of the Power Distribution of Signals Propagated Through Elevated Tropospheric Ducts", Master's Thesis, September 1982.

Title: Millimeter Wave Network Analyzer

Investigator: Jeffrey B. Knorr, Professor of Electrical Engineering

Sponsor: NPS Foundation Research Program

Objective: To construct an automated millimeter wave scalar net-
work analyzer system and to mathematically model the
system response.

Summary: A mathematical model of a scalar network analyzer has
been developed using scattering parameters. A milli-
meter wave analyzer system has been constructed and
the experimentally observed behavior has been found
to agree with that predicted by the model. Optimum
procedures for calibrating the system and for es-
tablishing bounds on measurement error have been
determined. The relationship between system per-
formance and component specifications has been care-
fully established. System software development work
is currently in progress.

Publication: J. B. Knorr, "Scattering Analysis of a Millimeter
Wave Scalar Network Analyzer", in progress.

Thesis Directed: Charles Shultheis, "A Model for a Millimeter Wave
Network Analyzer Test Set", Masters Thesis, June 1982.

Title: Computer Region Segmentation on Aerial Photographs

Investigator: C. H. Lee, Associate Professor of Electrical
                    Engineering

Sponsor: NPS Foundation Research Program

Objective: The objective of this work is to improve the per-
                    formance of existing algorithms for region segmen-
                    tation applied to high resolution aerial photographs.

Summary: A Recursive Splitting method at hierarchical scopic
                    levels will be developed and implemented. This re-
                    quires a special data structures constructed in the
                    memory space of the computer. To evaluate this
                    scheme, it is necessary to implement this structure
                    in a virtual memory machine. The iteration criterion
                    in the algorithm will include diagonal profile con-
                    sideration. Special problems caused by discontinuous
                    boundaries from splitting at different levels will be
                    solved by adjacency propagation of thresholds".

                    A digital aerial photograph of 5000 x 5000 resolution
                    will be used as a baseline data set. The work is
                    divided into the following phases:

                    Phase 1: Prepare and reformat the data set

                    Phase 2: Develop software on the host for the COMTAL
                              display system

                    Phase 3: Implement the hierarchical scopic level
                              structure

                    Phase 4: Implement the output data structure to
                              resolve the boundary discontinuity problem

                    Phase 5: Experiment and compare the proposed algo-
                              rithm with other algorithms for region
                              segmentation

                    During the period from 1 June to 30 September 1982,
                    Phase 1 and Phase 2 were accomplished.

Publications: C. H. Lee, "Iterative Region Segmentation",
                    Proceedings of Image Processing and Pattern
                    Recognition Conference, 1982.

                    C. H. Lee, "Interpolation of Weighted Average Samples
                    Using B-Spline Functions", in progress for IEEE
                    Proceedings.

Title:	Computed Aided Design of Microprocessor Based System
Investigator:	H. H. Loomis, Jr., NAVELEX Chair Professor of Electrical Engineering
Sponsor:	Naval Electronics Systems Command
Objective:	The development of a computer aided system for the design of dedicated microprocessor based systems.

Summary:

This project builds upon earlier work of my students Ross and Matelan which proposed and demonstrated the feasibility of a system for the computer aided design of microprocessor based control systems. The design process starts with a description of the control system involving contingencies (happenings in the system to be controlled) and resulting tasks (calculations and setting of outputs in the controlling computer). Statements in this description call forth segments of software and pieces of hardware necessary for their execution from a library and build a specification of the complete microprocessor control system. Finally, the design system analyzes the timing behavior of the machine designed and compares it to the timing constraints given in the initial problem statement. If the specifications are not met, multiple microprocessor realizations are explored and then other libraries (different microprocessor families) are tried.

The project has been established at NPS with the following achievements: submission of a conference paper describing the recent progress in the project, tentative identification of 3 potential thesis students who have started research on the project, commencement of the effort required to transport the existing computer programs done by Ross and by Pollock to an NPS Computer. The effort on this project will increase substantially with the arrival of Dr. Ross as a faculty member of the Department of Computer Science.

| Publication: | Alan Ross, H. H. Loomis, Jr., and G. Pollock, "An Approach to Computer Aided Design of Hardware and Software", Proceedings of the Allerton Conference, October 6-8, 1982. |

Title: Design of High Speed Recursive Digital Filters

Investigator: H. H. Loomis, Jr., NAVELEX Chair Professor of
                    Electrical Engineering

Sponsor: Naval Electronic Systems Command

Objective: The employment of pipeline techniques in the design
                    of high speed digital filters.

Summary: The project is concerned with the employment of
                    pipeline techniques in the design of digital filters.
                    It is well known that pipeline techniques can be
                    employed in non-recursive digital filters, that is,
                    digital filters without feedback. Because of the
                    feedback required to implement recursive digital
                    filters, there is no corresponding way to employ
                    pipeline techniques for the speeding up of digital
                    filters. This work further extends the original
                    discovery of a way to apply pipeline techniques to
                    recursive filter design, made at UC Davis (Patent
                    applied for).

Publication: H. H. Loomis, Jr. and B. Sinka, "High Speed
                    Realization of Recursive Filters Digital Filters",
                    submitted to the International Journal of Circuits
                    and Systems.

Title: Search Algorithms and Architectures

Investigators: H. H. Loomis, Jr., NAVELEX Chair Professor, (Acting for L. A. Cox, Assistant Professor of Computer Science), H. Fredricksen, Associate Professor of Mathematics

Sponsor: Department of Defense

Objective: To create at the Naval Postgraduate School a secure, digital state-of-the-art facility where research into SIGINT problems could be conducted; (2) stimulate a multi-disciplinary group of faculty members to consider Search related studies; and (3) provide an environment where our students, talented armed forces officers, can pursue their academic research, while gaining exposure and experience in the "real world" problems of SIGINT Search.

Summary: A small computer controlled receiver and signal analysis system has been designed and is currently under construction. The system will incorporate a high-speed analog to digital converter and an add-on array processor supplied by R6. The design is expandible, and fully supports parallel processing by disimilar devices. This system will permit NPS students to engage in meaningful hands on projects in the application of computer systems to search algorithms and to search modernization. The system will be able to operate at the SI/TK level, and will be the only such facility available at that level at NPS.

Professor Hal Fredrickson (Mathematics) has been engaged in research on the applications of shift register sequences to Search problems. This work has resulted in the offering of a special study course to advanced NPS graduate students on the subject. The course was offered in the Winter Quarter and had 6 credit students and 3 auditors.

Thesis Directed: Don B. DeCaria, "High Frequency Spread Spectrum Techniques: An Investigation of Current Methods of Reception", Master's Thesis, July 1982.

Title: Tactical Information Systems

Investigator: H. H. Loomis, Jr., NAVELEX Chair Professor, (Acting
                    for L. A. Cox, Assistant Professor of Computer
                    Science)

Sponsor: Naval Electronics Systems Command

Objective: To develop hardware architectures and software tech-
                    niques to support the delivery of timely, accurate
                    tactical data derived from off-board sensors to the
                    tactical commander. This data will be delivered in a
                    form to be compatable with existing, upgraded and
                    planned new shipboard tactical information systems.

Summary: A study has been made of the requirements for tacti-
                    cal information desired, the command, computer archi-
                    tectures and communication architectures to provide
                    this information derived from National Sensors.

Thesis Directed: David Burrill, "Solving US Navy Tactical Information
                    Flow Problems by Using Data Base Management Tech-
                    niques", Master's Thesis, June 1982.

Title: Cybernetic Models of Military C^{3}I Systems

Investigators: P. H. Moose, Associate Professor of Electrical
                    Engineering, K. E. Woehler, Professor of
                    Physics

Objective: Development of a possible conceptual basis
                    for defining and evaluating military C^{3}I
                    systems is the long term objective. The
                    immediate objective is to explore two such
                    conceptual models:
                    a) A highly aggregate Lanchester type model
                    in which military forces and information
                    are treated as assets subject to gain and
                    attrition processes. The equilibria and
                    their stability are to be investigated.
                    b) A continuum theory of an information and
                    command flow hierarchy controlling an
                    interacting military force environment is
                    to be developed with the aim to find useful
                    "structure functions" of C^{3}I systems for
                    which their influence on system performance
                    can be studied.

Summary: Under item a) above the dynamics of the
                    interactions between forces and information
                    has been modeled by non-linear evolution
                    equations. The attrition functions are
                    approximated by polynomials of second
                    degree. The various terms are identified
                    with C^{3}I, counter C^3, intelligence and
                    firepower of the forces. At least one of
                    the possible stationary points is easily
                    determined. Linear stability analysis
                    shows this equilibrium to be
                    environmentally unstable; that is, a smooth
                    variation in one of the parameters (here
                    the C^{3}I effectiveness) can change the
                    stagnant conflict into one with a decisive
                    outcome. In the case of stable equilibrium
                    a force multiplication ratio is defined by
                    the ratio of the force replenishment rates.
                    This ratio from the C^{3}I, counter C^3,
                    intelligence and firepower parameters of
                    the model gives a quantitative measure of
                    effectiveness for the value of C^3 to the
                    fighting forces.

Under item b) a system has been constructed that mimics many aspects of a hierarchical C^3I system. The environment with which the system interacts and about which it attempts to obtain knowledge is characterized by a multidimensional state vector $E(k)$. The system structure is governed by 13 structure functions which regulate the method of obtaining and distributing knowledge about the system and reacting to changes in the environment through a goal and command structure. The model is mathematically a system of coupled integrodifferential equations for the functions characterizing the state of knowledge and the command state.

The model needs to be programmed for computer calculations to study system responses to modifications in $E(k)$.

Publication: P. H. Moose, "Dynamics of Modern Military Conflicts," NPS Progress Report, NPS62-82-047PR, October 1982.

Conference
Presentation: P. H. Moose, "Extensions of Lanchester Equations", ONR/MIT C^3 Workshop, NPS, Monterey, CA   August 1982.

Thesis Directed: T. W. Fox, "An Investigation of the Dynamic Model of Modern Military Conflict", Master's Thesis, March 1982.

Title:	Measurement of Natural Resonance Parameters for Radar Target Identification
Investigator:	M. A. Morgan, Associate Professor of Electrical Engineering
Sponsor:	Office of Naval Research
Objective:	To advance the state-of-the-art in experimental and theoretical techniques for radar target identification through the use of natural resonances extracted from scattered echo signatures.

Summary: Theoretical and experimental work in the areas of target recognition and imaging via transient scattering responses has been an ongoing effort at the Naval Postgraduate School (NPS) for the past 3 years. This research was initially sponsored through the NPS Research Foundation and was first approached via direct target imaging. This continued effort, sponsored by ONR, utilizes natural resonances.

There are two particular aspects of this present endeavor. The first of these is the continued development and improvement of a computerized experimental facility which synthesizes wide-band resonance region radar returns, and then performs subsequent signal processing to stimulate the operations of proposed non-cooperative target recognition (NCTR) systems. A second important task will be to catalog the measured natural resonances of a wide variety of radar targets, which are of interest to the Navy, through the use of scale models.

Conference Presentations:	M. A. Morgan and C. W. Hammond, "Data Acquisition and Processing in Transient Scattering Measurements", 1981 IEEE/AP-S Symposium, Los Angeles, CA, June 1981.
	M. A. Morgan and M. L. Van Blaricum, "Considerations of Resonance Extraction from Transient Scattering Measurements", 1982 National Radio Science Meeting, Boulder, CO, Jan 1983.
Theses Directed:	R. Davenport, "Natural Resonance Radar Target Identification", Master's Thesis, September 1982.
	F. M. C. Manilha, "Investigation of Methods for Natural Resonance Radar Target Identification", Master's Thesis, December 1982.

Title:	Transient Scattering and Signal Processing
Investigator:	M. A. Morgan, Associate Professor of Electrical Engineering
Sponsor:	Defense Advanced Research Projects Agency (DARPA)
Objective:	Using transient electromagnetic scattering measurments from scale model radar targets the broadband RCS is evaluated for Rayleigh and Resonance region frequencies.

Summary:

This is a continuing investigation concerning the optimum synthesis of radar cross section (RCS) from transient measurements of scattering. Three particular tasks have received intensive consideration. There has been an in-depth study and measurements concerning s-plane RCS measurement not in the theoretical far-field. Secondly, there is a continuing theoretical-experimental study regarding the physical SEM representation of target transient response in the early-time while under driver excitation and to consider the implications of this regarding signal processing strategies and s-plane representation of RCS. Finally, there has been development of an optimal theoretical technique for system deconvolution which will be used for scatterer impulse response synthesis. Near-term future efforts call for the construction of a new anechoic chamber for improved scattering measurements capability.

Conference Presentations:

M. A. Morgan and C. W. Hammond, "Data Acquisition and Processing in Transient Scattering Measurements", 1981 IEEE/AP-S Symposium, Los Angeles, CA, June 1981.

M. A. Morgan and M. L. Van Blaricum, "Considerations of Resonance Extraction from Transient Scattering Measurements", 1982 National Radio Science Meeting, Boulder, CO, Jan 1983.

Theses Directed:

R. Davenport, "Natural Resonance Radar Target Identification", Master's Thesis, September 1982.

F. M. C. Manilha, "Investigation of Methods for Natural Resonance Radar Target Identification", Master's Thesis, December 1982.

Title:	Digital Signal Processing - I

Investigators: S. R. Parker, Professor of Electrical Engineering, and Y. C. Lim, NRC Postdoctoral Research Associate

Sponsor: NPS Foundation Research Program

Objective: To study techniques for the design and implementation of digital signal processing algorithms.

Summary: During this period several important results have been achieved. An efficient algorithm for the design of finite impulse response (FIR) digital filters with finite coefficient word length has been developed, using a minimum least mean squares error criteria between the performance of the filter and the specification. This algorithm allows for the design of filters of order well beyond other approaches by a factor of three for the same computer time. Other work includes the synthesis of lattice parameter digital filters, the design of FIR for a finite power-of-two coefficient field, and decimation techniques for the efficient implementation of digital filters using microprocessors. These contributions are discussed in detail in the publications which follow.

Publications: Y. C. Lim and S. R. Parker, "Discrete Coefficient FIR Digital Filter Design Based on an LMS Criteria," IEEE Transactions on Circuits and Systems, to appear October 1983.

Y. C. Lim and S. R. Parker, "Efficient FIR Filter Implementation Using Microprocessors," IEEE Transactions on Acoustics, Speech and Signal Processing submitted 1982.

Y. C. Lim, S. R. Parker and A. Constantinides, "Finite Wordlength FIR Filter Design Using Integer Programming Over a Discrete Coefficient Space," IEEE Transactions on Acoustics, Speech and Signal Processing Vol 30, No. 4, August 1982, pp. 661-64.

Y. C. Lim and S. R. Parker, "FIR Filter Design Over a Discrete Powers-of-Two Coefficient Space," IEEE Transactions on Acoustics, Speech and Signal Processing June 1983.

Y. C. Lim and S. R. Parker, "On the Synthesis of Lattice Parameter Digital Filters," IEEE Transactions on Circuits and Systems, submitted 1982.

Conference Presentations:	Y. C. Lim and S. R. Parker, "Digital Lattice Filter Design Using a Frequency Domain Criteria," <u>Proceedings of IEEE International Conference on Acoustics, Speech and Signal Processing</u>, Paris 1982, pp 282-5.

Y. C. Lim and S. R. Parker, "A Discrete Coefficient FIR Digital Filter Design Based on an LMS Criteria," <u>Proceedings IEEE International Symposium on Circuits and Systems</u>, Rome 1982, pp. 296-299.

Y. C. Lim and S. R. Parker, "On the Synthesis of Lattice Parameter Digital Filters," IEEE International Conference on Acoustics, Speech and Signal Processing, accepted for 1983.

Y. C. Lim and S. R. Parker, "Efficient FIR Filter Implementation Using Microprocessors," IEEE International Converence on Acoustics, Speech and Signal Processing, accepted for 1983.

Y. C. Lim, S. R. Parker and A. Kayran, "A Decimation Technique for Optimal Data Transfer in One and Two-Dimensional FIR Digital Filter Implementations," IEEE International Symposium on Circuits and Systems, accepted for 1983.

Y. C. Lim and S. R. Parker, "Filter Design Over a Discrete Powers-of-Two Coefficient Space," IEEE International Symposium on Circuits and Systems, accepted for 1983.

Title:	Digital Signal Processing - II
Investigators:	S. R. Parker, Professor of Electrical Engineering, and J. J. Thomas, NRC Postdoctoral Research Associate
Sponsor:	NPS Foundation Research Program
Objective:	To study techniques for the design and implementation of digital signal processing algorithms.

Summary: This research has concentrated on two areas; the modeling and identification of nonlinear discrete time systems and the use of finite field arithmetic for the implementation of digital algorithms.

The discrete nonlinear moving average identification problem has been shown to be contained within a two dimensional impulse response solution, where convolution is applied in the nonlinear dimension regardless of the order of the nonlinearity. This approach has been generalized using tensor notation and operations which are readily programmed. Also the use of the DFT for Volterra kernel identification, separability tests for cascaded linear/nonlinear subsystems, stability test, and spectral analysis have been considered.

Arithmetic operations defined over a finite field, $GF(P)$ have the advantage of exact calculations. It has been shown that implementation of modular arithmetic can be realized with minimal effort in already existing hardware. In addition, operations over the ring of integers Mod p^N, $N>1$, $GF(p^2)$ and the ring Mod p^2 can be easily formulated using the operations over $GF(P)$. Mathematical operations of this type are especially useful in algorithms or processes which are unstable due to roundoff or truncation.

In addition to the publications which follow five additional papers have been prepared and submitted for publication.

Publications: S. R. Parker, L. Mayoral and J. J. Thomas, "An Adaptive Kalman Identifier and Its Application to Linear and Nonlinear ARMA Modeling," Proceedings of the 16th Princeton Conference on Information Sciences and Systems, March 1982, 6 pages.

S. R. Parker and J. J. Thomas, "Analysis and Identification of Discrete Nonlinear Moving Average Systems," submitted to IEEE Transactions on Circuits and Systems, Nov. 1982.

J. J. Thomas and S. R. Parker, "Modeling Nonlinear Systems with a Discrete Volterra Series Expansion," in Proceedings of 25th Midwest Symposium on Circuits and Systems, Michigan Technology University, August 1982.

Title:	Discrete Signal Processing Studies
Investigator:	S. R. Parker, Professor of Electrical Engineering
Sponsor:	Naval Electronics Systems Command
Objective:	To develop new algorithms for processing discrete signals with application to digital filter design and implementation analog circuit performance evaluation and fault detection, speech, image processing and radar.

Summary: During the report period a number of new techniques for the design of digital filters have been developed. These included lattice filter design from specifications, optimal filter design with finite precision coefficients, and efficient filter implementation with microprocessors and VLSI. The research has also included the development of several computer programs for calculation lattice parameters from sampled input/output data of analog circuits, in the time and frequency domains. These lattice parameters have been demonstrated to be useful as features to evaluate analog circuit performance and help with fault detection.

Publications:

Y. C. Lim, S. R. Parker, A. Constantinides, "Finite Wordlength FIR Filter Design Using Integer Programming Over a Discrete Coefficient Space," IEEE Transactions on Acoustics, Speech and Signal Processing, Vol. 30, No. 4, August 1982, pp 661-64.

Y. C. Lim and S. R. Parker, "FIR Filter Design over a Discrete Powers-of-Two Coefficient Space," IEEE Transactions on Circuits and Systems, forthcoming.

Y. C. Lim and S. R. Parker, "Discrete Coefficients FIR Digital Filter Design Based on an LMS Criteria," Submitted to IEEE Transactions on Acoustics, Speech and Signal Processing, 1982.

Y. C. Lim and S. R. Parker, "Efficient FIR Filter Implementation Using Microprocessors," Submitted to IEEE Transactions on Acoustics, Speech and Signal Processing, 1982.

J. J. Thomas and S. R. Parker, "Exact Calculation of Algorithms," in progress.

J. J. Thomas and S. R. Parker, "Exact Calcuation in Galois Fields, GF(p)," in progress.

Y. C. Lim and S. R. Parker, "On the Synthesis of Lattice Parameter Digital Filters," submitted to IEEE Transactions on Circuits and Systems, 1982.

Conference Presentations:	Y. C. Lim and S. R. Parker, "Digital Lattice Filter Design Using a Frequency Domain Criteria", <u>Proceedings of IEEE International Conference on Acoustics, Speech, Signal Processing</u>, Paris, 1982, pp. 182-5.
	Y. C. Lim and S. R. Parker, "A Discrete Coefficient FIR Digital Filter Design Based on LMS Criteria", <u>Proceedings of IEEE International Symposium on Circuits and Systems</u>, Rome, 1982.
	Y. C. Lim and S. R. Parker, "On the Synthesis of Lattice Parameter Digital Filters", IEEE International Conference on Acoustics, Speech and Signal Processing, accepted for 1983.
	Y. C. Lim and S. R. Parker, "Efficient FIR Filter Implementation Using Microprocessors", IEEE International Conference on Acoustics, Speech and Signal Processing, accepted for 1983.
	S. R. Parker, Y. C. Lim and A. Kayran, "A Decimation Technique for Optimal Data Transfer in One and Two-Dimensional FIR Digital Filter Implementations", IEEE International Symposium on Circuits and Systems, accepted for 1983.
	Y. C. Lim and S. R. Parker, "Filter Design Over a Discrete Powers-of-Two Coefficient Space", IEEE International Symposium on Circuits and Systems, accepted for 1983.
Theses Directed:	F. X. Wright, "A VHSIC Macrocell Set and Some Applications to Signal Processing", <u>Master's Thesis</u>, December 1981.
	D. J. Grandia, "Modeling of an Active Tscheybychev Filter with Lattice Parameters", <u>Master's Thesis</u>, December 1981.
	B. P. Brown, "The Use of Lattice Models in Fault Diagnosis of Analog Circuits", <u>Electrical Engineer's Thesis</u>, December 1981.
	D. J. Klich, "Efficient Multichannel Autoregressive Modeling in Time and Frequency Domain", <u>Ph.D Thesis</u>, March 1982.
	J. A. Geraci, "The Determination of Lattice Parameters from System Data", <u>Master's Thesis</u>, June 1982.
	I. K. Chang, "On the Design of Finite Impulse Response Digital Filters with Discrete Coefficients", <u>Master's Thesis</u>, December 1982.

M. Powers, "A Comparison of Approaches to Multi-channel "Modeling", Master's Thesis, September 1982.

A. I. Liaskos, "The Use of Transitional Formulations for Zero-Pole Modeling", Master's Thesis, March 1982.

R. B. Leonard, "Discriminating a Class on Nonstation-ary Signals", Master's Thesis, June 1982.

Title: Reduced Order Characterization of Circuits and Systems/Nonlinear Fault Detection

Investigators: S. R. Parker, Professor of Electrical Engineering, C. W. Therrien, Visiting Professor MIT Lincoln Laboratories

Sponsor: Office of Naval Research

Objective: To investigate techniques for the macroscopic modeling of linear and nonlinear circuits and systems for purpose of performance analysis and fault detection.

Summary: During the report period research has been directed to the modeling of nonlinear systems using an adaptive Kalman identifier approach, and a discrete Volterra series approach. The latter approach has been shown to be contained within a two-dimensional impulse response solution, regardless of the order of the nonlinearity. This approach has been generalized using sensor notations and operations which are readily programmed. The research has also included the successful modeling and identification of a class of random processes, based upon a generalized likelihood ratio test involving a set of delay-lock loops. The latter problem is applicable to the identification of radar targets as well as other applications.

Publications: J. J. Thomas and S. R. Parker, "On the Analysis and Identification of Nonlinear Moving Average Systems", submitted to special issue of IEEE Transactions.

C. W. Therrien and S. R. Parker, "Discrimination of Random Delay Modulated Signals with Application to Target and System Identification", in progress.

S. R. Parker and A. Kayran, "Lattice Parameter Modeling of Two-Dimensional Signals", in progress.

Conference Presentations: S. R. Parker, "Multichannel Lattice Analysis and Synthesis Models", IFAC Symposium on Theory and Application of Digital Control, New Dehli, 1982, 6 pages.

J. J. Thomas and S. R. Parker, "Modeling Nonlinear Systems with a Discrete Volterra Series Expansion", Proceedings of the 25th Midwest Symposium on Circuits and Systems, Michigan Technology University, August 1982.

S. R. Parker, L. Mayoral and J. J. Thomas, "An Adaptive Kalman Identifier and Its Applications to Linear and Nonlinear ARMA Modeling", Proceedings of the 16th Int. Sciences and Systems Conference, Princeton, 1982, 6 pages.

C. W. Therrien, S. R. Parker and R. B. Leonard, "Discrimination of a Set of Delay Modulated Signals with Application to Radar Target Identification", Asilomar Conference on Circuits and Systems, November 1982.

Theses Directed: A. I. Liaskos, "The Use of Transitional Formulations for Zero-Pole Modeling", Master's Thesis, March 1982.

R. B. Leonard, "Discrimination a Class of Nonstationary Signals", Master's Thesis, June 1982.

Title: Electro-optic Instrumentation Link

Investigator: J. P. Powers, Professor of Electrical Engineering

Sponsor: Combat Developments Experimentation Command

Objective: To develop a laser data link between a helicopter in-
                    strumentation pod and a receiver mounted at a fuse-
                    lage window. The system retransmits a coded laser
                    signal received by the pod and superimposes a channel
                    code. The receiver was required to decompose the
                    channel code from the transmitted signal and to pro-
                    cess the coded laser signal.

Summary: The desired link was designed and successfully tested
                    in the laboratory environment. A Ga As pulsed laser
                    was used with pulse position modulation to transmit
                    the coded signal after verification of a proper sig-
                    nal. A window occurring in the coded signal was used
                    to superimpose the proper digital code to indicate
                    the channel or channels that received the orginal in-
                    formation. The digital receiver regenerated the
                    clock, removed the channel information from the win-
                    dow and verified that the remaining coded signal was
                    a proper code for further processing (usually radio
                    telemetry).

Thesis Directed: W. W. Higgins, "Electro-optic Instrumentation Link
                    for the Combat Development Experimentation Command's
                    Direct Fire Simulator", Master's Thesis, June 1982.

Title:	Fiber Optics in Underwater Range Applications
Investigator:	J. P. Powers, Professor of Electrical Engineering
Sponsor:	Naval Underwater Warfare Engineering Station
Objective:	This work is investigating aspects of fiber optic communications for suitability in underwater range applications. Investigations include technology tracking, data relay design and underwater testing of various links.

Summary:

1. Technology survey. While long wavelength sources and receivers have become available, prices remain prohibitively high for system application. Most range applications do not require the low losses or the small dispersion except for the shore link carrying multiplexed signals a long distance.

2. Computer interconnecters. A prototype link for driving various RS-232 peripherals was designed and successfully tested. One key element of the system was a bidirectional coupler requiring only one bidirectional fiber between devices rather than two. Investigations continue on the appropriateness of wavelength division multiplexing for this application.

3. Underwater data link. An underwater data uplink has also been designed and used in experimental data collection. Operating at a depth of 90 meters the link interconnected a PCM signal from a magnetometer with a sonobuoy transmitter. Suitable underwater housings and bulkhead penetrators were designed, and fiber optic cable used. The system is battery powered and successfully operates in excess of twenty-four hours.

Theses Directed:

Dana Rowland, " Fiber Optic Interface for Computer Peripherals", Master's Thesis, December 1982.

Gary Thomas, "Serial Data Communication Using an HFBR-0500 Fiber Optic System", Master's Thesis, October 1982.

Arnold Gritzke/Robert Johnson, "Fiber Optic Underwater Uplink for Digital Data", (Tentative Title), in progress.

Title: Processing Architectures for Advanced Warning Systems

Investigator: Tien F. Tao, Professor of Electrical Engineering

Sponsor: Air Force Space Division

Objective: Generic study of focal plane processing algorithms
                        and implementations for advanced warning systems
                        for ballistic missile surveillance

Summary: Advanced Warning System is a joint Air Force and
                        DARPA program to develop advanced technologies
                        required to support the development of next genera-
                        tion space surveillance systems to provide long
                        range early warning of ballistic missile attacks.
                        Two of the major risk areas are the image processing
                        algorithms to process large amounts of sensor
                        data from the new large mosaic sensor arrays and
                        the implementations of these image processing
                        algorithms and other system control and management
                        tasks on-board the spacecraft.

                        This study has two parts.

                        First, new algorithms in the threshold and post-
                        threshold stages are being developed continually.
                        During this reporting period, our research has
                        been concentrated in the target acquisition and
                        track association area. Specifically, we have
                        developed a three step process which simplified
                        significantly the techniques used before. The
                        first step is a thresholding process which used
                        a very simple procedure to raise the threshold
                        value until the number of hits collected after
                        thresholding dropped below a selected value. It
                        is much simpler than the "histogram counting"
                        method used before. The second step is a target
                        acquisition process using a "side-lobe discrimi-
                        nation" approach. The discrimination between a
                        moving target and a random false alarm is based
                        on the fact that a moving target has definite side-
                        lobe pattern after it is processed by a temporal
                        filter. On the other hand, a random false hit
                        will not show the same side-lobe pattern. This
                        side-lobe discrimination step turned out to be an
                        effective step to discard a large fraction of the
                        false hits. This is followed by the third step
                        of post-threshold processing which is based on
                        track files build up for every candidate targets
                        with new track, accepting track and dropping
                        track logic.

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This new thresholding and post-thresholding program has been tested on a series of infrared images generated from the data collected by the HCMM satellite and compared with image processing techniques developed before. Improvements have been made not only in processing speed but also in the amount of memory needed to process the tracks.

The second part is the implementation of these image processing algorithms by a multiple microcomputer system. During this reporting period, the study has been concentrated in the evaluation of the concurrent computing performance of tightly coupled multiple microcomputer systems. Specifically, several benchmark test programs based on parallel processing have been developed. Two figures of merit have been defined to describe the enhancement of processing throughput by the system: speed-up and concurrent-computing overhead. Four parameters have been defined to describe the conditions of a concurrent computation: number of processors, system, execution overhead and intercommunication overhead. A model has been developed to calculate the speed-up performance of tightly coupled multiple-computer systems and compared with real measurements performed on our own multiple microcomputer system. The agreements between measured results and analysis are satisfactory except that some normalizations must be made for the execution overhead and the communication overhead parameters. It indicated that the basic concept of this modeling is sound. However, the selection of these four independent parameters may have to be improved.

Thesis Directed: F. Davenport Jr., "Comparison of Two End-to-End Staring Infrared Mosaic Tracking Programs, <u>Master's Thesis</u>, December 1981.

PROFESSOR TIEN F. TAO, DEPARTMENT OF ELECTRICAL ENGINEERING EXPLAINS THE MULTIPLE MICROCOMPUTER SYSTEM TO DR. ROBERT FROSCH, V.P. FOR RESEARCH, GENERAL MOTORS CO.
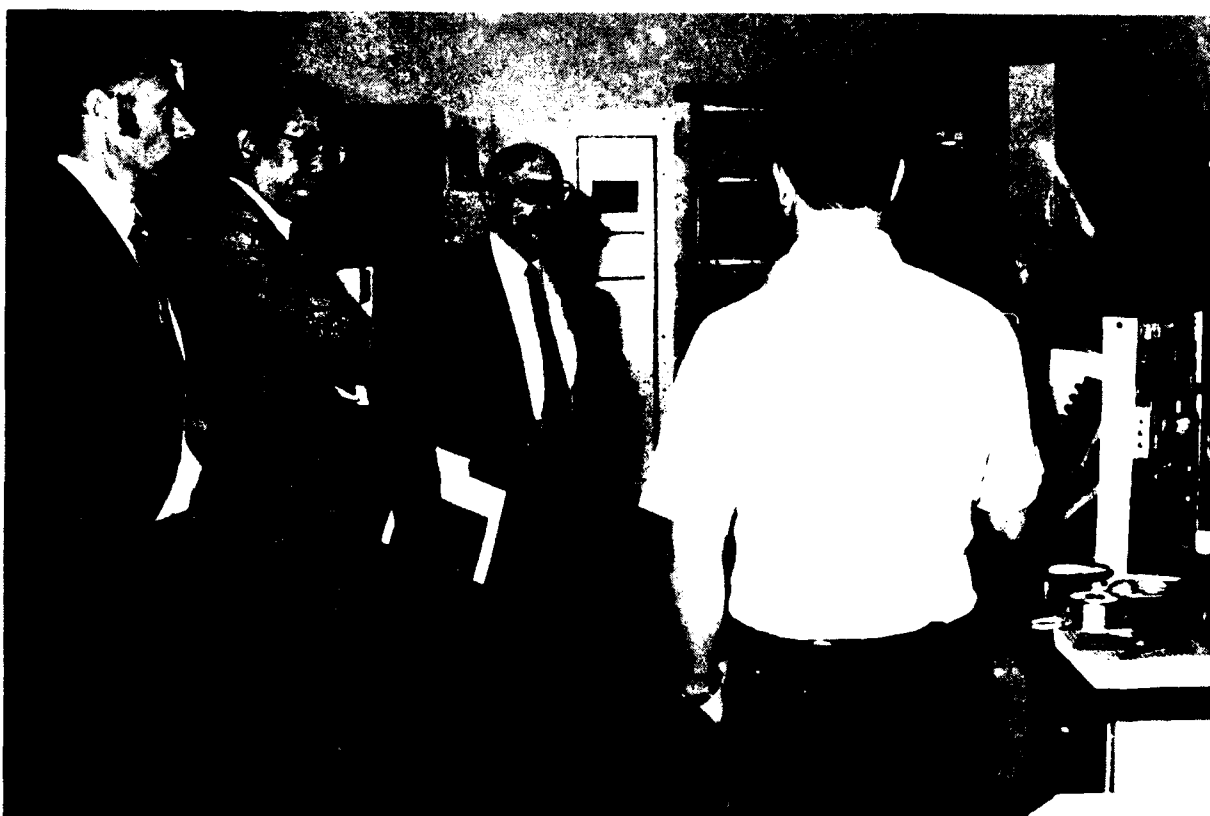
STUDENT DESCRIBES SECURE MICROCOMPUTER DEVELOPMENT TO DR. ROBERT
FROSCH, PROFESSOR TIEN F. TAO, DEPARTMENT OF ELECTRICAL ENGINEERING
AND WILLIAM M. TOLLES, DEAN OF RESEARCH AT NPS.

Title:	Automatic Radar Ship Classification for Cruise Missiles
Investigator:	Lonnie A. Wilson, Associate Professor Electrical Engineering
Sponsor:	Joint Cruise Missiles Project Office
Objective:	To develop automatic radar ship classification techniques and technologies for cruise missile applications.

Summary: The U.S. Navy has limited target classification capabilities for long stand-off range, all weather, multiple targets and day/night applications. In the past, the Navy has focused significant resources on the target detection and target tracking problems. Now that the target detection problem has been largely solved, target classification stands out as a major deficiency for numerous Navy missions. Significant research and technology advances are required to solve this target classification problem for cruise missile applications.

Several new ship target classification algorithms have been developed for the Automatic Radar Ship Classification for cruise missiles project. The Correlation algorithm has been developed and successfully evaluated for a small number of ship targets. The PDF/Entropy classification algorithm has been developed and successfully evaluated for a limited number of ship classes. Also, significant analysis has been completed on a shift and scale invarient preprocessor for future extraction and selection.

Publications: Lonnie A. Wilson and Norman Huston, "The Design and Tactical Implementation of a Sorting Parameter Trade-off Study, U. S. DoD Tri-Service Conference - Total Target Identification Technology, October 1981.

Lonnie A. Wilson, "Missile Targeting Requirements Problems", Technical Proceedings of the 1982 Tri-Service Missile Ship Targeting Workshop, August 1982.

Lonnie A. Wilson and Thomas L. Swafford, "Unintention_ Frequency Modulation of RF Emitter", NPS Technical Report, 62-82-940TR, April 1982.

Conference
Presentations: Lonnie A. Wilson and Norman Huston, "The Design and Tactical Implementation of a Sorting Parameter Trade-Off Study", Tri-Service Conference - Total Target Identification Technology, New Jersey, October 1982.

Lonnie A. Wilson, "Missile Targeting Requirements Problems", Technical Presentation at the 1982 Tri-Service Missile Ship Targeting Workshop, Washington, D. C., August 1982.

Theses Directed: G. Wasenius, "Ship Profile Identification", Electrical Engineer's Thesis, September 1982.

A. J. Christian, "Application of Correlation Classifier to Automatic Ship Classification", Master's Thesis, June 1982.

N. Huston, Jr., "Shift and Scale Invarient Preprocessor", Electrical Engineer's Thesis, December 1981.

D. Greaser, "Investigation of the Frequency Modulation on Pulse Characteristics of Simple Filters", Master's Thesis, September 1982.

Title:	IR Ship Target Classification
Investigator:	Lonnie A. Wilson, Associate Professor of Electrical Engineering
Sponsor:	Chief of Naval Research
Objective:	To develop an IR ship classification system using a FLIR sensor.

Summary: The U.S. Navy is keenly interested in the development of automatic techniques for ship targets classification/identification. This research project is investigating the potential of several classification algorithms for IR ship classification. The signal processing and classification algorithms will be compatible with conventional FLIR's and FPA FLIR systems. The two algorithms being developed are the PDF/Entrophy algorithm and the Slope Density Function Algorithm. This research project will be continued during FY83.

Theses Directed: G. Wasenius, "Ship Profile Identification", Electrical Engineer's Thesis, September 1982.

A. J. Christian, "Application of Correlation Classifier to Automatic Ship Classification", Master's Thesis, June 1982.

Title:	Multi-Source Track Management
Investigator:	Lonnie A. Wilson, Associate Professor of Electrical Engineering
Sponsor:	Naval Sea Systems Command
Objective:	To provide theoretical analysis and system tradeoff analysis for the MSTM function of the ACDS. Automatic track management and multi-source identification (MSID) processing architectures and algorithms will be developed, analyzed and evaluated.

Summary: The U. S. Navy has advanced combat direction systems (ACDS) requirements to fully develop sensor and C^3I assets for multi-source track management (MSTM). Current Navy systems have good automatic target detection and limited target tracking capabilities. New Navy ACDS systems should provide improved automatic MSTM with automatic multisource classification, identification and track. This is a new research project.

DEPARTMENT

OF

METEOROLOGY

DEPARTMENT OF METEOROLOGY

The research program in the Department of Meteorology continues in several areas: (1) numerical air and ocean modeling and prediction, (2) analysis and dynamics of tropical weather systems, (3) marine atmospheric boundary layer studies, (4) marine fog/visibility analysis and prediction, (5) regional weather studies and (6) satellite remote sensing. Under each of these headings, a number of related investigations have been pursued by various faculty members.

NUMERICAL MODELING AND PREDICTION

R. T. Williams is developing and testing numerical procedures for global and regional weather prediction. He is investigating various finite element formulations with respect to treatment of small-scale flow fields. He will apply the techniques to the prediction of air flow near mountains, and to tropical cyclones. Professor Williams has also modified an existing model to determine better the changes which occur in frontal structure when a front moves over a surface where moisture and temperature properties are changing.

R. L. Elsberry and R. W. Garwood, Jr. (Oceanography) have used a one-dimensional mixed-layer model to predict the upper ocean response to atmospheric forcing on time scales ranging from diurnal to seasonal changes. In a joint effort with R. L. Haney, the mixed-layer model has been embedded into an oceanic general circulation model. This new model will now be used in a variety of oceanic investigations including the response of the ocean to tropical and extratropical storms (R. L. Elsberry) and the dynamics of large scale low frequency variability in the North Pacific Ocean (R. L. Haney).

A combined diagnostic-prognostic approach is being used by R. L. Elsberry, C. H. Wash and S. A. Sandgathe to study maritime extratropical cyclones. The atmospheric model being implemented at the Fleet Numerical Oceanography Center has been used to study the role of air-sea fluxes in extratropical cyclogenesis. Diagnostic studies of the numerically-predicted fields are being made for comparison with similar studies using real data.

Other modeling efforts include (1) a dynamical-statistical model for predicting the movement of tropical cyclones, led by R. L. Elsberry, (2) a marine atmospheric boundary layer model for predicting (6-18 hours) properties which affect radar and optical propagation within the boundary layer and those factors (radiation and boundary fluxes) which affect the upper part of the ocean, directed by K. L. Davidson, (3) the beginning of a comparison of several global initialization schemes by a Ph.D. candidate under the supervision of R. T. Williams, and (4) a study on the impact and methods of coupling an ocean mixed-layer model to an atmospheric prediction system (R. L. Elsberry and S. A. Sandgathe).

ANALYSIS AND DYNAMICS OF TROPICAL WEATHER SYSTEMS

C.-P. Chang, R. L. Elsberry and R. T. Williams continue to investigate various aspects of the dynamics of tropical weather systems, including development of hurricanes and typhoons by R. L. Elsberry, the dynamics and energetics of tropical synoptic and planetary scale waves by C.-P. Chang and R. T. Williams, and the diagnostic analysis of winter and summer monsoon circulations by C.-P. Chang. C.-P. Chang is also joined by Research Chair Professor P. J. Webster in the study of midlatitude-tropical interactions. M. A. Rennick, R. L. Haney and C.-P. Chang are investigating mechanisms of large-scale air-sea interaction in the tropics using coupled numerical models. The work concentrates on ocean temperature and atmospheric circulation anomalies associated with El Nino.

MARINE ATMOSPHERIC BOUNDARY LAYER STUDIES

Research in this area includes several interdisciplinary shipboard/aircraft observational and theoretical projects involving K. L. Davidson. Objectives of the individual projects are: (1) to evaluate and formulate models which relate changes in the depth and structure of the atmospheric mixed layer (capped by an inversion) to surface fluxes and sky conditions, (2) to evaluate and formulate models for equilibrium marine aerosol distributions, (3) to establish synoptic-scale descriptions of the magnitude and height variations of optical turbulence, (4) to relate near-surface aerosol distributions to whitecap coverage, (5) to determine dispersion properties of the atmospheric boundary layer in the California coastal region and (6) to evaluate synoptic-scale forcing on the boundary processes and evolutions utilizing data from single (in situ) stations. Long range objectives of this work are to provide tactical assessment and predictive procedures for electromagnetic, optical and dispersion properties of the marine boundary layer.

MARINE FOG/VISIBILITY ANALYSIS AND PREDICTION

An interdisciplinary project involving R. J. Renard, and D. F. Leipper and G. H. Jung from the Department of Oceanography, is concerned with the climatology, analysis and numerical/statistical prediction of fog and visibility over open ocean and coastal regimes, both on a regional and a hemispheric scale. On a regional basis a synoptic-oriented marine fog visibility sequential development model continues in a test mode for the eastern North Pacific Ocean coastal area and the open ocean areas in the Gulf of Alaska and western North Pacific Ocean vicinity of 34N-164E. On a whole ocean basis, a model output statistics scheme is being coevaluated with persistence and climatology for forecasting marine visibility over the North Pacific Ocean to 48 hours.

REGIONAL WEATHER STUDIES

Pressure, temperature and vector wind data from the Antarctic remote-site automatic weather stations continue to be analyzed by R. J. Renard and associates for their contribution to the climatology and improved operational weather forecasting in the area surrounding McMurdo, Antarctica.

The project to assess the status of and make improvements on operationally-important weather parameters over the Southern African Continent and surrounding ocean areas continued in FY 82.

SATELLITE REMOTE SENSING

K. L. Davidson was involved with observational studies concerned with surface truth evaluation of satellite-borne scatterometer derived estimates of the oceanic surface layer wind and satellite-borne microwave radiometer derived estimates of the sea-surface temperature. Furthermore, aerosol distribution data obtained off the California coast are being used to assess the role of atmospheric extinction of 'grey shade' patterns within usual satellite imagery (DMSP). C. H. Wash is applying interactive computer techniques to GOES and NOAA visual, infrared and other radiometric data to specify cloud and precipitation patterns using the NEPRF Satellite Processing and Acquisition System.

Title: Interactions of Synoptic and Interannual Variations
of Large-Scale Motions during Winter

Investigator: Chih-Pei Chang, Professor of Meteorology

Sponsor: National Oceanic and Atmospheric Administration

Objective: To study the interannual variations of the large-
scale flow over the Asia-Pacific region and their
interaction with the synoptic time scales.

Summary: Grid point wind data during the winter MONEX of 1978
-79 were used to show a significant departure of the
divergence field from those of the early 1970's in
that the tropical divergence center was shifted from
the maritime continents to the south central Pacific.
In view of this, the evolution of tropical motion
following surges was composited and the planetary
scale teleconnection pattern was found to change
somewhat from the earlier seasons. The differences
in midlatitude flow structure between Winter MONEX
and earlier seasons was also studied. The major
difference appears to be in the long wave pattern
over East Asia, which caused the Winter MONEX cold
surges to be weaker than normal.

Publications: C.-P. Chang, K. M. Lau, "Short-Term Planetary-Scale
Interactions over the Tropics and Midlatitude during
Northern Winter. Part I: Contrasts between Active
and Inactive Periods", Monthly Weather Review, 110,
August 1982, 933-946.

K. M. Lau, C.-P. Chang, P. Chan, "Short-Term Plane-
tary Scale Interactions over the Tropics and Midlati-
tude during Northern Winter. Part II: Winter MONEX
Periods", Monthly Weather Review (forthcoming).

Conference
Presentations: C.-P. Chang, K. M. Lau, "Planetary-Scale Circulations
during Winter Monsoons", International Conference on
the Scientific Results of the Monsoon Experiment,
Bali, Indonesia, October 1981, Proceedings, World
Meteorological Organization, 1982, 2/20-2/23.

C.-P. Chang, K. M. Lau, "Short-Term Planetary-Scale
Teleconnection during Winter", 14th Technical Con-
ference on Hurricanes and Tropical Meteorology, San
Diego, June 1982, Abstracts, American Meteorological
Society, 1982, 17.

K. M. Lau, P. Chan, C.-P. Chang, "A Diagnostic Study
of Large-Scale Circulation Changes during Northeas-
terly Cold Surge Periods", 14th Technical Conference
on Hurricanes and Tropical Meteorology, San Diego,
June 1982, _Abstracts, American Meteorological So-
ciety_, 1982, 16.

Title:	Synoptic Studies of Cold Surge Initiation
Investigators:	Chih-Pei Chang, Professor of Meteorology and James S. Boyle, NRC **Post**doctoral Research Associate
Sponsor:	NPS Foundation Research Program
Objective:	To study the behavior of midlatitude circulations before, during and after cold surges in the Asian winter monsoon.

Summary: A detailed synoptic study of the December 1974 and December 1978 data are carried out to study the sequence of events in the extratropical latitudes during East Asian cold surge periods. It was found that the most important large scale system is the upper tropospheric long wave ridge-trough pattern over East Asia where the ridge supports the surface Mongolian high through continued cold air advection. The major difference in the ridge-trough between the two Decembers causes considerable differences in the surge activities. Secondary circulations were calculated to show the possible important mechanisms for instigating the cold surges in the subtropical latitudes.

Conference
Presentation: J. S. Boyle, "Synoptic Study of the Initiation of Surges", Winter MONEX Workshop, Monterey, CA, June 1982, 14-15.

Title:	Tropical Large-Scale Ocean-Atmosphere Ocean Coupling
Investigators:	Chih-Pei Chang, Professor of Meteorology Mary Alice Rennick, Adjunct Research Professor of Meteorology and K. M. Lau, Visiting Scientist
Sponsor:	National Science Foundation
Objective:	To study the mutual influence of tropical large-scale atmospheric circulation and the upper layer of the ocean over time scales synoptic to interannual.

Summary: This work has been continued with basic experiments using a coupled ocean-atmosphere model. Both the atmosphere and the ocean were described by shallow-water equations. Simple analytic solutions for atmospheric motion correspondence to a given heat source were obtained to represent the large-scale Walker-type circulation in the atmosphere. The coupling was effected by specifying the position and the strength of the heat source as a nonlinear function of the large-scale sea level slope which in turn depended on the wind stress input from the model atmosphere. Parallel observational studies revealed the presence of a bimodal climate state in the tropical ocean-atmosphere system over the Pacific. The effect of modal transitions in relation to large-scale atmosphere-ocean interaction in modifying the onset and subsequent evolution of El Nino/southern oscillation was studied. A more sophisticated model was also developed. In it, the ocean circulation was forced by a surface wind stress term determined by a global spectral model of the atmosphere, and the atmospheric circulation was driven by a heating term determined by the sea surface temperature which was computed according to an idealized model of thermal processes in the ocean mixed layer. El Nino-like events were triggered by externally imposed changes in the mean trade wind field. The observed equatorial SST anaomaly in the central Pacific and the eastward shift of the upward branch of the Walker Circulation were reproduced by the model. Feedback effects were shown to lengthen the time scale and increase the magnitude of the event.

Publications: K. M. Lau, "A Simple Model of Atmospheric-Ocean Interaction during El Nino/Southern Oscillation." Tropical Ocean-Atmosphere Newsletter, 13, 1982.

K. M. Lau, "A Bimodal Climate State in the Tropical Atmosphere-Ocean System Associated with El Nino/ Southern Oscillation." Submitted to <u>Journal of Atmospheric Sciences</u>.

M. A. Rennick, "A Model of Atmosphere-Ocean Coupling in El Nino." <u>Tropical Ocean Atmosphere Newsletter</u>, forthcoming.

Conference
Presentations:

K. M. Lau, "Ocean-Atmospheric Coupling in he Tropical Pacific: A Simple Model of the Variation of Equatorial Sea Surface Temperature Associated with the Southern Oscillation/El Nino", Fourth Conference on Ocean-Atmosphere Interaction, San Diego, June 1982, <u>Abstracts, American Meteorological Society</u>, 1982, 47-48.

M. A. Rennick, "Atmospheric Response to El Nino", Fourth Conference on Ocean-Atmosphere Interaction, San Diego, June 1982, <u>Abstracts, American Meteorological Society</u>, 1982, 48.

Title: Tropical and Monsoon Studies

Investigators: Chih-Pei Chang, Professor of Meteorology and
                    R. T. Williams, Professor of Meteorology

Sponsor: National Science Foundation

Objective: To study the structure and dynamics of large-scale
                    flow in the tropics and other areas which are in-
                    fluenced by monsoons. This is a continuing pro-
                    ject.

Summary: The research project continues to progress on sev-
                    eral fronts, including: 1) Observational study of
                    cold surges: A composite study of the surface
                    structure of cold surges was completed, and gravi-
                    tational characteristics of the surges were found.
                    2) Observational study of planetary scale winter
                    monsoon: The teleconnection pattern during Winter
                    MONEX was studied. 3) Theoretical study of waves
                    in a mean jet with downstream variation: The non-
                    linear energy exchanges were computed for a baro-
                    tropic simulation of zonally-asymmetric, locally-
                    unstable mean flow. The nonlinear interaction with
                    the waves strongly stabilizes the flow downstream
                    from the jet maximum, and the waves display a sig-
                    nificant downstream variation in wavelength. 4)
                    Theoretical study of the viscous effect on equa-
                    torial waves: The Rossby waves were found to be
                    influenced by viscosity in reduced phase speed,
                    and a horizontal tilt. On the other hand, the
                    "viscous mode" response to heating does not appear
                    to be important. 5) Numerical simulation of East-
                    Asia Mei-Yu fronts: The convective latent heat
                    release was found important in sustaining a direct
                    secondary circulation which can produce the ob-
                    served low-level jet.

Publications: H. Lim, C.-P. Chang, "A Theory for Mid-Latitude
                    Forcing of Tropical Motions during Winter Monsoons,"
                    Journal of Atmospheric Science, 38, November 1981,
                    2377-2392.

                    C.-P. Chang, S. T. Wand, "Possible Two-Day Oscil-
                    lations in the Troposphere and Lower Stratosphere",
                    Papers in Meteorological Research, 4, December 1981
                    31-37.

C.-P. Chang, K. M. Lau, "Short-Term Planetary-Scale Interactions over the Tropics and Midlatitude Active and Inactive Periods", Monthly Weather Review, 110, August 1982, 933-946.

C.-P. Chang, H. Lim, "Effects of Viscous Damping on Equatorial Rossby Waves", Journal of Atmospheric Science, 39, August 1982, 1726-1733.

C.-P. Chang, J. E. Millard, and G. T. Chen, "Gravitational Character of Cold Surges during Winter MONEX", Monthly Weather Review, in progress.

C.-P. Chang, H. Lim, "Dynamics of Teleconnections and Walker Circulations Forced by Equatorial Heating", Journal of Atmospheric Science, in progress.

K. M. Lau, C.-P. Chang, and P. Chan, "Short-Term Planetary Scale Interactions over the Tropics and Midlatitude during Northern Winter. Part II: Winter MONEX Periods", Monthly Weather Review, forthcoming.

C.-P. Chang, Review of "Monsoon Dynamics, Lighthill and Pearce, Ed., Cambridge University Press, for EOS", Transactions of American Geophysical Union, 63, May 1982, 514.

R. T. Williams, L. C. Chou, and C. J. Cornelius, "Effects of Condensation and Surface Motion on the Structure of Steady-State Fronts", Journal of Atmospheric Science, 38, November 1981, 2365-2376.

K. M. Lau, "Equatorial Response to Northeasterly Cold Surges as Inferred from Satellite Cloud Imagery", Monthly Weather Review, 110, September 1982, 1306-1313.

Conference Presentations:

C.-P. Chang, K. M. Lau, "Planetary-Scale Circulations during Winter Monsoons", International Conference on the Scientific Results of the Monsoon Experiment, Bali, Indonesia, October 1981, Proceedings, World Meteorological Organization, 1982, 2/20-2/23.

R. T. Williams, C.-P. Chang, T. Y. Tsay, and H. Lim, "Nonlinear Barotropic Motions in a Zonally Varying Easterly Jet", International Conference on the

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Scientific Results of the Monsoon Experiment, Bali, Indonesia, October 1981, Proceedings, World Meteorological Organization, 1982, 1/53-1/56.

H. Lim, C.-P. Chang, "A Linear Theory on Midlatitude Forcing of Tropical Motions during Winter Monsoon Surges", International Conference on the Scientific Results of the Monsoon Experiment, Bali, Indonesia, October 1981, Proceedings, World Meteorological Organization, 1982, 2/16-2/19.

C.-P. Chang, G. Chen, T. E. Gerish, "Structure of the Quasi-Stationary Cyclonic Circulation near Borneo during Winter MONEX", International Conference on the Scientific Results of the Monsoon Experiment, Bali, Indonesia, October 1981, Proceedings, World Meteorological Organization, 1982, 5/59-5/62.

K. R. Saha, C.-P. Chang, "Development of Monsoon Depressions: Two Contrasting Cases", International Conference on the Scientific Results of the Monsoon Experiment, Bali, Indonesia, October 1981, Proceedings, World Meteorological Organization, 1982, 4/40-4/43.

C.-P. Chang, K. M. Lau, "Short-Term Planetary-Scale Teleconnection during Winter", 14th Technical Conference on Hurricanes and Tropical Meteorology, San Diego, June 1982, Abstracts, American Meteorological Society, 1982, 17.

K. M. Lau, P. Chan, C.-P. Chang, "A Diagnostic Study of Large-Scale Circulation Changes during Northeasterly Cold Surge Periods", 14th Technical Conference on Hurricanes and Tropical Meteorology, San Diego, June 1982, Abstracts, American Meteorological Society, 1982, 16.

H. Lim, C.-P. Chang, K. M. Lau, "A Theory on Global Responses to Equatorial Forcing," 14th Technical Conference on Hurricanes and Tropical Meteorology, San Diego, June 1982, Abstracts, American Meteorological Society, 1982, 17.

L. C. Chou, R. T. Williams, "Numerical Simulation of East Asia "Mei-Yu" Fronts," Fifth Conference on Numerical Weather Prediction, Monterey, CA. American Meteorological Society. October 1981. Abstract in Bulletin of the American Meteorological Society, 62, 1982, 905.

Title:	Atmospheric Forcing on Ocean-Atmospheric Mixed Layer
Investigators:	K. L. Davidson, Professor of Meteorology and G. E. Schacher, Professor of Physics
Sponsor:	Office of Naval Research
Objective:	Couple micro-computer coded models for the ocean (OBL) and atmosphere (ABL) well mixed boundary layers and evaluate joint responses in each layer on basis of predicted radiation and kinetic energy transfer.
Summary:	Separate ABL (Davidson, et al, 1983) and OBL (Garwood) micro-computer scaled models have been coded so they can be run simultaneously on a HP-9836 micro-computer. The primary identified effects of the coupled model prediction have been in the ocean regime wherein the radiation heating has a definite effect. The model has been tested on both clear and cloudy sky cases.
Thesis Directed:	M. C. O'Loughlin, "Formulation of Coupled Ocean and Atmospheric Mixed Layer Model," Master's Thesis, December 1982.

Title: Estimating Surface Layer Extinction from Optical
                    Depth Measurements

Investigators: K. L. Davidson, Professor of Meteorology, and
                    G. E. Schacher, Professor of Physics

Sponsor: Naval Environmental Prediction Research Facility

Objective: To relate surface layer extinction to optical
                    depth values occurring in different synoptic
                    regimes.

Summary: Vertical distributions of temperature and specific
                    humidity are assigned to synoptic regimes which
                    depend on mean vertical motion and sea surface
                    temperatures. Optical extinction is based on
                    water vapor absorption and aerosol scattering.
                    Different scaling is identified for synoptic
                    regimes formulated for the Navy Refractive Effects
                    Guide (REG).

Title:	Marine Boundary Layer Modeling for the Aerosol Contribution to Optical Extinction
Investigators:	K. L. Davidson, Department of Meteorology, and G. E. Schacher, Department of Physics
Sponsor:	Naval Ocean Systems Center (EO/MET Program)
Objective:	Validate a model that will have real time assessment capability and the ability to predict on a 6-24 hour time period the affect of aerosols on optical propagation in the marine atmospheric boundary layer.

Summary: Several tasks were completed in FY82 to check the physical assumptions of the modeling approach. They are:

a. Verification of physical assumptions of the integrated model approach and verification of the NPS model using CEWCOM-78 and MAGAT data;

b. Verification of the ability to determine optical extinction from aerosol size distribution measurements using MAGAT data.

c. Completed reduction of STREX aerosol data.

Publications: A. K. Goroch, C. W. Fairall and K. L. Davidson, "Modeling Wind Speed Dependence by a Gamma Function," Journal of Applied Meteorology, 21, 1982, 666-671.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Meteorological Models for Optical Properties in the Marine Atmospheric Boundary Layer," Optical Engineering, 21, 1982, 847-857.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Applications of a Mixed Layer Model to Aerosols in the Coastal Marine Boundary Layer," Proceedings, Conference on Meteorology and Air/Sea Interaction in the Coastal Zone, American Meteorological Society, Netherlands, 1982, 7 pp.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Applications of a Mixed Layer Model to Aerosols in the Marine Boundary Layer," submitted to Tellus.

K. L. Davidson and L. Schutz, "Observational Results on the Influence of Surface Layer Stability and Inversion Entrainment on Surface Layer Marine Aerosol Number Density (1 μm)," <u>Optical Engineering</u>, 1982.

Thesis Directed: S. M. Reece, "Evaluation of IR Range Assessment Procedures for Mediterranean," <u>Master's Thesis</u>, September 1982.

Title:	Observational Studies of Marine Boundary Layer Processes
Investigators:	K. L. Davidson, Professor of Meteorology, and G. E. Schacher, Professor of Physics
Sponsor:	Naval Air Systems Command
Objective:	Prediction of the evolution of a marine atmospheric boundary layer.

Summary: This research program consists of a boundary layer model development and an experimental field program. The modeling effort is based on the empirical relation of entrainment at the top of the layer to the surface fluxes. The intention is to allow prediction of boundary layer evolution from routine shipboard radiosonde and future surface layer winds. The model includes the effects of subsidence and radiation.

Publications:

G. E. Schacher, K. L. Davidson, D. E. Spiel and C. W. Fairall, "Marine Atmospheric Surface Layer Measurements on the NOAA Ship Oceanographer during STREX," U.S. Department of Commerce Report Storm Transfer and Response Experiment, 1981, 137-141.

K. L. Davidson, D. Brower, G. E. Schacher and C. W. Fairall, "Atmospheric Marine Boundary Layer Predictions for Weapons Systems," Proceedings, Science and Engineering Symposium, Dayton, Ohio, 1981, 22 pp.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "A Review and Evaluation of Integrated Atmospheric Boundary Layer Models for Maritime Applications," NPS Technical Report NPR 63-81-004, 1981, 89 pp.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Generation Rate of Marine Aerosols as Determined from a Boundary Layer Model," NPS Technical Report, NPS 63-82-003, 1982, 29 pp.

K. L. Davidson, G. E. Schacher, C. W. Fairall, P. Jones Boyle and D. A. Brower, "Marine Atmospheric Boundary Layer Modeling for Tactical Use," NPS Technical Report, NPS 63-82-001, 1982, 48 pp.

K. L. Davidson, G. E. Schacher, C. W. Fairall,
E. C. Crittenden and E. A. Milne, "Verification of
the Bulk Model for Calculations of the Overwater
Index of Refraction Structure Function, C_N^2,"
NPS Technical Report, NPS 61-80-016, 1980, 42 pp.

G. E. Schacher, K. L. Davidson and C. W. Fairall,
"Observation on Turbulent Kinetic Energy Dissipa-
tion Rates, ϵ, over the Ocean," Boundary Layer
Meteorology, 20, 1981, 321-330.

K. L. Davidson, G. E. Schacher, C. W. Fairall and
A. Goroch, "Verification of the Bulk Method for
Calculating Overwater Optical Turbulence,"
Applied Optics, 20, 1981, 2919-2924.

K. L. Davidson, G. E. Schacher and C. W. Fairall,
"Meteorological Descriptions for Optical Proper-
ties," AGARD Conference Proceedings #300, Special
Topics in Optical Propagation, 1981, 6-1 - 6-9.

C. W. Fairall, K. L. Davidson and G. E. Schacher,
"Meteorological Models for Optical Properties in
the Marine Atmospheric Boundary Layer," Proceedings,
S.P.I.E. 25th International Technical Symposium,
August 1981, 16 pp.

Theses Directed: D. A. Brower, "Micro-Computer Based Prediction
Model for Marine Atmospheric Boundary Layer,"
Master's Thesis, March 1982.

J. P. Gleason, "Single Station Assessment of
Synoptic Scale Forcing of the Atmospheric Well
Mixed Layer," Master's Thesis, September 1982.

R. M. Graves, "Evaluation of Atmospheric Mixed
Layer Model for Tactical Use in Data Sparse
Regions," Master's Thesis, December 1982.

Title: Optical Turbulence in the Marine Boundary Layer

Investigator: K. L. Davidson, Professor of Meteorology, and
G. E. Schacher, Professor of Physics

Sponsor: High Energy Laser Program Office

Objective: Relate surface layer optical turbulence (C_N^2) to seasonal and geographic synoptic meteorological regimes and evaluate Wyngaard-Lemone inversions.

Summary: Mean and median C_N^2 values were related to synoptic scale features on an approach which used to describe EM wave propagation (Refractive Effects Guidebook). Observed surface layer wind, temperature and humidity values and surface temperatures were used in bulk aerodynamic expression to estimate C_N^2. Data used were from experiments conducted by NPS personnel. Airborne data during MAGAT, Gulf of Mexico and White Sands Missile Range experiments have been evaluated relative to Wyngaard-Lemone inversion scaling procedures.

Publications: C. W. Fairall, "Factors Relating Surface Visibility to the Total Optical Depth in the Marine Regime," NPS Contract Report, NPS 63-82-004CR, 1982, 29 pp.

K. L. Davidson, G. E. Schacher, C. W. Fairall and A. Goroch, "Verification of the Bulk Method for Calculating Overwater Optical Turbulence," Applied Optics, 20, 1981, 2919-2924.

C. W. Fairall, "An Analysis of the Wyngaard-Lemone Model of Refractive Index and Micrometeorological Structure Functions at the Top of a Turbulent Mixed Layer," NPS Contract Report, NPS 63-82-006CR, 1982, 101 pp.

Thesis Directed: T. R. McPherson, "Synoptic Classification of Optical Turbulent Regimes," Master's Thesis, December 1981.

Title: Relating Marine Aerosol Distribution to Oceanic
                Whitecaps

Investigators: K. L. Davidson, Professor of Meteorology, and
                G. E. Schacher, Professor of Physics

Sponsor: Office of Naval Research

Objective: To determine aerosol production per unit whitecap
                coverage on the basis of laboratory measurements
                and to relate open ocean aerosol data and whitecap
                coverage.

Summary: Analyses have been performed on data obtained in
                June 1980 over laboratory generated whitecaps at
                University College, Galway. Preliminary estimates
                were obtained of the produced aerosol size distri-
                butions as a function whitecap coverage (Monahan
                et al, 1982), based on data obtained in 1979.
                Aerosol size distributions obtained during JASIN
                (North Atlantic) experiment in 1978 have been in-
                terpreted relative to aerosol flux spectra (Fairall
                et al, 1982) and whitecap coverage (Monahan et al,
                1983).

Publications: E. C. Monahan, K. L. Davidson, D. E. Spiel, "White-
                cap Aerosol Productivity Deduced from Simulation
                Tank Measurements," Journal Geophysical Research,
                87, 1982, 8898-8904.

                C. W. Fairall, K. L. Davidson and G. E. Schacher,
                "An Analysis of the Surface Production of Sea Salt
                Aerosols,"submitted to Tellus, 1982.

                E. C. Monahan, C. W. Fairall, K. L. Davidson and
                P. J. Boyle, "Observed Inter-relationships amongst
                10 m Elevation Winds, Oceanic Whitecaps and Marine
                Aerosols," submitted (revised) to Quarterly Journal
                Royal Meteorological Society, 1982.

Title: Maritime Cyclones

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: To understand and improve predictions of smaller
                     scale cyclones that affect fleet operations over
                     the mid-latitude oceans.

Summary: This is the initial effort of a wide-ranging
                     project treating cyclones over the oceans. A
                     multi-year research project funded by NASA has
                     resulted from this effort and the atmospheric-
                     ocean coupling work will be proposed to ONR and
                     NAVAIR.

Publications: R. L. Elsberry, R. L. Haney, R. T. Williams, R. S.
                     Bogart, H. D. Hamilton and E. F. Hinson, "Ocean-
                     Troposphere-Stratosphere Forecast System," Naval
                     Environmental Prediction Research Facility
                     Contract Report, NEPRF CR 82-04, 1982.

                     R. L. Elsberry, S. A. Sandgathe and F. J.
                     Winninghoff, "Short-Term Oceanic Response Pre-
                     dicted by a Mixed Layer Model Forced with a Global
                     Sector Atmospheric Model," submitted to
                     Journal of Physical Oceanography, 1982.

Title: Modelling Upper Ocean Thermal Structure

Investigators: R. L. Elsberry, Professor of Meteorology, and
                        R. W. Garwood, Jr., Associate Professor of
                        Oceanography

Sponsor: Naval Ocean Research and Development Activity

Objective: Application of a one-dimensional oceanic boundary
                        layer model for prediction of the upper ocean
                        thermal structure.

Summary: Our ultimate goal in this continuing project is to
                        assist in the development of an ocean model to pre-
                        dict ocean thermal structure changes that have an
                        important impact on environmental support for
                        fleet operations. Our particular interest is in
                        ocean prediction on time scales ranging from di-
                        urnal to seasonal periods. Correction fields to
                        be applied to the Fleet Numerical Oceanography Cen-
                        ter surface heat fluxes have been derived so that
                        these fluxes may be used in ocean prediction ex-
                        periments (Elsberry, Gallacher, Bird and Garwood,
                        1982). Some preliminary predictions of sea-surface
                        temperature anomalies between Hawaii and San
                        Francisco have been completed (Steiner, 1981;
                        Steiner and Elsberry, 1981).

Publications: R. L. Elsberry, S. A. Sandgathe, and F. J.
                        Winninghoff, "Short-Term Oceanic Response Pre-
                        dicted by a Mixed Layer Model Forced with a Global
                        Sector Atmospheric Model," submitted to Journal of
                        Physical Oceanography, 1982

                        R. L. Elsberry, P. C. Gallacher, A. A. Bird and
                        R. W. Garwood, Jr., "Deriving Corrections to FNOC
                        Surface Heat Flux Estimates for Use in North
                        Pacific Ocean Predictions," NPS Technical Report,
                        NPS 63-82-005, 1982.

Conference   E. F. Steiner and R. L. Elsberry, "Experimental
Presentations: Predictions of Sea-Surface Temperature Anomalies
                        between Hawaii and San Francisco," Abstract,
                        American Geophysical Union Annual Fall Meeting,
                        San Francisco, CA, December, 1981.

P. C. Gallacher and R. W. Garwood, Jr., "The Effects of Turbulent Mixing on SST Anomalies in the Central North Pacific," Abstract, American Geophysical Union Annual Fall Meeting, San Francisco, CA, December, 1981.

Thesis Directed: E. J. Steiner, "One-Dimensional Model Predictions of Upper Ocean Temperature Changes between San Francisco and Hawaii," Master's Thesis, December, 1981.

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Title:	Oceanic Thermal Response to Atmospheric Forcing
Investigator:	R. L. Elsberry, Professor of Meteorology
Sponsor:	Office of Naval Research, Ocean Science Division

Objective: Understand and predict those changes in near-surface oceanic variables that are related to atmospheric forcing, especially on diurnal and synoptic time scales.

Summary: Oceanographic and meteorological observations and numerical simulations are used to understand the role of atmospheric forcing of the upper ocean layers. Initial tests with a data assimilation method appropriate for use with a bulk, oceanic mixed layer model have been published (Elsberry and Warrenfeltz, 1982). Estimates are being made of the errors in ocean thermal structure predictions at Ocean Weather Ship P due to incomplete or inaccurate initial data, and due to inaccurate atmospheric forcing. Ocean current measurements obtained by NAVOCEANO as hurricane Frederic passed have been compared with numerical simulations (Hopkins, Elsberry and Shay, 1982). Oceanic response to mid-latitude and equatorial atmospheric forcing has been demonstrated with Garwood's ocean model and a version of the UCLA general circulation model (Elsberry, Sandgathe and Winninghoff, 1982).

Publications: R. L. Elsberry and L. L. Warrenfeltz, "Data Assimilation Tests with an Oceanic Mixed Layer Model," Journal of Physical Oceanography, 12, 1982, 839-850.

R. L. Elsberry, S. A. Sandgathe and Francis J. Winninghoff, "Short-Term Oceanic Response Predicted by a Mixed Layer Model Forced with a Global Sector Atmospheric Model," 1982, submitted to Journal of Physical Oceanography.

Conference Presentations: D. Larsen and R. L. Elsberry, "Real-Data Tests of an Ocean Mixed Layer Model Assimilation Technique," Abstract, American Geophysical Union Annual Fall Meeting, San Francisco, December, 1981.

R. L. Elsberry and L. L. Warrenfeltz, "Analysis of Upper Ocean Thermal Structure Using a Data Assimilation Technique," Abstract, American

Geophysical Union Annual Fall Meeting, San Francisco, December, 1981.

C. K. Hopkins, R. L. Elsberry and L. K. Shay, "Ocean Current Response to Hurricane Passage," <u>Abstract</u>, American Meteorological Society Conference on Sea-Air Interaction, San Diego, CA, June, 1982.

S. A. Sandgathe, R. L. Elsberry and F. J. Winninghoff, "Ocean Thermal Response to a Global Sector Atmospheric Numerical Model," <u>Abstract</u>, American Meteorological Society Conference on Sea-Air Interaction, San Diego, CA, June, 1982.

Theses Directed: D. G. Larsen, "Oceanic Data Assimilation Tests with a One-Dimensional Model " <u>Master's Thesis</u>, December, 1981.

C. K. Hopkins, "Ocean Response to Hurricane Forcing," <u>Master's Thesis</u>, June, 1982.

Title:	Tropical Cyclone Studies
Investigator:	R. L. Elsberry, Professor of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	To improve numerical predictions of tropical and extratropical circulation systems in which convective clouds play an important role.

| Summary: | An effort to improve dynamical tropical cyclone track predictions by statistical post-processing techniques has continued (Elsberry, Gilchrist and Peak, 1981; Peak and Elsberry, 1982a). The feasibility of applying the Nested Tropical Cyclone Model to predict Southern Hemisphere storms has been demonstrated (Peak and Elsberry, 1982b). An efficient method based on empirical orthogonal function analysis has been used to represent the synoptic forcing of tropical cyclone motion (Shaffer, 1982; Shaffer and Elsberry, 1982a and b). |

Publications:	R. L. Elsberry, R. C. Gilchrist and J. E. Peak, "Statistical Post-Processing of HATRACK Tropical Cyclone Track Forecasts," Papers in Meteorological Research, 4, 1981, 21-30.
	J. E. Peak and R. L. Elsberry, "A Simplified Statistical Post-Processing Technique for Adjusting Tropical Cyclone Tracks," Papers in Meteorological Research, 1982.
	A. R. Shaffer and R. L. Elsberry, "A Statistical-Climatological Tropical Cyclone Track Prediction Technique Using an EOF Representation of the Synoptic Forcing," Monthly Weather Review, 110, 1982.
Conference Presentations:	A. R. Shaffer and R. L. Elsberry, "Typhoon Motion Forecasting Using Empirical Orthogonal Function Analysis of the Synoptic Forcing," Abstract, American Meteorological Society 14th Technical Conference on Hurricanes and Tropical Meteorology, San Diego, June, 1982.

J. E. Peak and R. L. Elsberry, "Statistical Post-Processing of the Navy Nested Tropical Cyclone Model and the Operational Tropical Cyclone Model," <u>Abstract</u>, American Meteorological Society 14th Technical Conference on Hurricanes and Tropical Meteorology, San Diego, June, 1982.

Thesis Directed: A. R. Shaffer, "Typhoon Motion Forecasting Using Empirical Orthogonal Function Analysis of the Synoptic Forcing," <u>Master's Thesis</u>, March, 1982.

Title:	Numerical Modeling of Large-Scale Ocean Variability
Investigator:	R. L. Haney, Associate Professor of Meteorology
Sponsor:	Office of Naval Research
Objective:	To continually develop and improve a numerical model of the North Pacific Ocean circulation and to use the model to investigate large-scale variability in the upper ocean.
Summary:	A ten-year hindcast of the large-scale temperature and currents in the Central Midlatitude North Pacific Ocean during 1969-78 has been carried out using a multi-level primitive equation ocean circulation model driven by observed (FNOC) winds and climatological heating. The results are being compared with the TRANSPAC temperature anomaly data and McNally's drifter data in order to investigate (1) the seasonal and interannual variability of the sea surface temperature, (2) the statistical relationship between the surface stress and the currents in the upper 200 m, and (3) the large-scale variability of temperature in the vicinity of the main thermocline.
Publications:	D. Adamec, R. L. Elsberry, R. W. Garwood, Jr. and R. L. Haney, "An Embedded Mixed Layer-Ocean Circulation Model," Dynamic Atmosphere and Oceans, 5, 1981, 69-96.
	R. L. Haney, M. S. Risch and G. C. Heise, "Wind Forcing Due to Synoptic Storm Activity over the North Pacific Ocean," Atmosphere-Ocean, 19, 1981, 128-147.
	R. L. Haney, B. H. Houtman and W. H. Little, "The Relationship between Wind and Sea Surface Temperature Anomalies in the Midlatitude North Pacific Ocean," Atmosphere-Ocean, 21, 1983, forthcoming.
Conference Presentations:	R. L. Haney and B. H. Houtman, "Wind and Sea Surface Temperature Anomalies in the North Pacific," American Geophysical Union Annual Fall Meeting, San Francisco, CA, December 7-11, 1981.

R. L. Haney, "Numerical Model Studies of the Mid-latitude North Pacific Ocean," Study Conference on Large-Scale Oceanographic Experiments in the World Climate Research Programme, Tokyo, May 10-21, 1982.

Title:	Marine Boundary Layer Forecasting
Investigators:	R. J. Renard, Principal Investigator, Professor and Chairman, Department of Meteorology; D. F. Leipper, Professor Emeritus, Department of Oceanography G. H. Jung, Professor, Department of Oceanography W. J. Thompson, Meteorologist, Department of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	To improve the analysis and forecasting of marine boundary layer parameters over the open ocean and coastal areas.

Summary: Further modification and verification of the model output statistics (MOS) scheme for forecasting summer-season marine visibility over the North Pacific Ocean (20-70N), out to 48 h, was accomplished in FY 82. Both persistence and climatological forecast schemes were developed and co-evaluated with the (MOS) approach. Threat and skill scores and forecast bias calculations indicate the MOS forecasts to excel both persistence and climatology. Preparations are underway to adapt the MOS scheme to Fleet Numerical Oceanography Center operations. Work with the synoptic-oriented sequential marine fog/visibility development model continued. The United States west-coast version of the model continues in an experimental operational phase at the Pacific Missile Test Range, Pt. Mugu, CA. In its present form, visibility in one of the four categories may be probabilistically estimated out to eight days for non-frontal events, as a function of the normal sequential variation of boundary-layer inversion height. The coastal version of the development model has been extended and modified for the summer season (1967-71), western North Pacific Ocean area surrounding the OSV "V" (35N-164E). Testing indicates success in predicting advection fog occurrences as a function of the following indices: boundary-layer inversion height, air/ sea temperature, moisture and wind parameters. Project terminated end of FY 82.

Conference R. J. Renard and T. N. Talbot, "Development of
Presentations: a Marine Surface Visibility Climatology for the
North Pacific Ocean," Proceedings 9th Conference
on Weather Forecasting and Analysis, Seattle, WA,
July 1982, 465-468.

D. F. Leipper, "West Coast Marine Fog; a Warm or
a Cold Water Phenomenon?", Proceedings First In-
ternational Conference on Meteorology and Air/
Sea Interaction of the Coastal Zone, The Hague,
Netherlands, May 10-14, 1982, 315-320.

Title:	Regional Synoptic Forecasting: Southern Africa
Investigators:	R. J. Renard, Principal Investigator, Professor and Chairman, and W. J. Thompson, Meteorologist, Department of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	To assess the status of and make improvements on the analysis and forecasting of weather parameters important to air/sea operations over the Southern African Continent and surrounding South Atlantic/ Indian Ocean areas (approximately 10-60S, 75E-15W).

Summary:	Literature and climatologies of the important dynamic, thermal and moisture parameters of the defined area were assembled and assimilated. Identification of important synoptic/mesoscale circulations/elements of interest to air/sea operations was begun. Analysis series (seasonal examples) from FNOC and one or more S. African Continent Weather sources are in the process of being obtained.

Title: Diagnostics of Oceanic Extratropical Cyclones

Investigator: C. H. Wash, Assistant Professor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: To transfer and develop a variety of limited-area
                    diagnostic programs for the study of observed and
                    numerically-simulated extratropical cyclone
                    studies and to apply these techniques to the
                    study of oceanic cyclogenesis.

Summary: During FY82 circulation and vorticity budget pro-
                    grams with output displays were completed and a
                    circulation and angular momentum study of observed
                    east-coast cyclogenesis conducted using data from
                    the First Global GARP Experiment. Also the diag-
                    nostics were applied to a numerical simulation of
                    open-ocean cyclogenesis by a version of the NOGAPS
                    operational model.

Publication: C. Wash with L. Uccellini, P. Kocin, R. Petersen
                    and K. Brill, "The President's Day Cyclone, 18-19
                    February 1979. Part I: An Analysis of Subtropical
                    and Low-Level Jet Streaks Prior to Cyclogenesis,"
                    Monthly Weather Review, forthcoming.

Conference   C. Wash with L. Uccellini and P. Kocin, "An Analy-
Presentations: sis of the LFM-II Simulations of the President's
                    Day Cyclone, February 18-19, 1979," Fifth Confer-
                    ence on Numerical Weather Prediction, Monterey,
                    CA, November 2-6, 1981.

                    C. Wash, P. Conant and D. Roman, "Quasi-Lagrangian
                    Mass, Angular Momentum and Circulation Budgets
                    for the President's Day Cyclone, 18-21 February
                    1979," Ninth Conference on Weather Forecasting
                    and Analysis, Seattle, WA, June 28-July 1, 1982.

PROFESSOR C.H. WASH, DEPARTMENT OF METEOROLOGY AND METEOROLOGY STU-DENT LT. W.E. CALLAND REVIEW DEFENSE METEOROLOGICAL SYSTEM SATELLITE IMAGERY IN CONNECTION WITH THE DIAGNOSIS AND PROGNOSIS OF A SIGNIFICANT NORTH PACIFIC OCEAN MARITIME CYCLONE.

Title:	Quantitative GOES Satellite Data Analysis using SATDAT Processing and Display System (SPADS)
Investigator:	C. H. Wash, Assistant Professor of Meteorology
Sponsor:	Naval Air Systems Command
Objectives:	Implement algorithms to analyze GOES visual, infrared and other channel data to produce probabilistic specification of hazardous surface weather for naval operations (presence of precipitation, precipitation intensity, low visibilities and ceilings) in silent areas between conventional observations using the SPADS system. Incorporate these methods with advective and extrapolation methods planned for SPADS to produce a probabilistic short-range forecast capability for hazardous weather over oceanic areas.

| Summary: | Research review of cloud and precipitation specification studies using satellite data was completed and a SPADS algorithm has been designed based on work of Lijas (1981) and Reynolds and VonderHaar (1977). It is being implemented currently. Colocated GOES and surface report data have been acquired for coastal regions and these data are being used to test and extend current cloud and precipitation specification schemes. |

| Conference Presentation: | C. Wash, "Cloud and Precipitation Specification Using GOES Data on SPADS," 1982 Navy/CSU Scientific Workshop, Monterey, CA, June 3-4, 1982. |

Title:	Development of Finite Element Prediction Model
Investigatros:	R. T. Williams, Professor of Meteorology; A. L. Schoenstadt, Professor of Mathematics; and R. E. Newton, Professor of Mechanical Engineering
Sponsor:	Naval Air Systems Command
Objectives:	To develop and test a finite element atmospheric prediction model.

Summary: Two finite element, vorticity-divergence prediction models were developed and tested. One employed bilinear basis functions on rectangular elements and the other used linear functions on triangular elements. An elliptic solver was adapted for both models. These finite element models were compared with finite difference solutions for analytic initial conditions.

Conference Presentations:

D. E. Hinsman, R. T. Williams and E. Woodward, "Recent Advances in the Glerkin Finite Element Method as Applied to the Meteorological Equations on Variable Resolution Grids," Fourth International Symposium on Finite Element Methods in Flow Problems, Tokyo, July 1982, paper in Proceedings of Fourth International Symposium on Finite Element Methods in Flow Problems, 843-850.

M. E. Older and R. T. Williams, "A Two-Dimensional Finite Element Advection Model with Variable Resolution," Fall Meeting of American Geophysical Union, San Francisco, CA, Abstract published in Transactions, American Geophysical Union, 62, 1981. 873.

R. T. Williams, "Formulation of Finite Element Atmospheric Prediction Models," Fall Meeting of American Geophysical Union, San Francisco, CA, Abstract published in Transactions, American Geophysical Union, 62, 1981, 873.

Title: Numerical Prediction Model Development

Investigators: R. T. Williams, Professor of Meteorology, and
                    M. A. Rennick, Adjunct Assistant Professor of
                    Meteorology

Sponsor: Naval Air Systems Command

Objectives: To develop and test better procedures for use in
                    Navy weather forecasting models.

Summary: Flow over surface topography was studied with the
                    following numerical models: 1) a finite differ-
                    ence model which is very similar to the NOGAPS
                    model which is in use at the Fleet Oceanography
                    Prediction Center, 2) the finite difference model
                    which was recently developed by Prof. A. Arakawa
                    at UCLA, 3) the spectral model which was developed
                    by Dr. T. Rosmond of the Naval Environmental
                    Prediction Research Facility. Some of the experi-
                    ments showed poor behavior near the tropopause
                    as a result of the vertical differencing.

Conference   R. T. Williams, J. Hayes, F. Winninghoff and
Presentation: O. Haney, "Numerical Simulation of Air Flow over
                    and around a Long Mountain Range," Fifth Confer-
                    ence on Numerical Prediction of American Meteoro-
                    logical Society, Monterey, CA, Preprint volume,
                    November 2-6, 1981, 137-138.

DEPARTMENT

OF

AERONAUTICS

DEPARTMENT OF AERONAUTICS

The research effort of the Aeronautics faculty covers a broad range of aeronautical engineering disciplines with special emphasis on Naval aviation problems.

AIRCRAFT COMBAT SURVIVABILITY STUDIES

Professor Ball is continuing his research in various areas of aircraft survivability, and progress was made in these areas: First, in a war-at-sea scenario, an examination was made of survivability for current naval aircraft. Second, in the survivability consideration in the Marine Direct Air Support Center (DASC) Operation, a digital computer program was developed and, consequently a report was written on the survivability of close air support aircraft. Third, in the survivability self-study program, one-hour lecture and self-study program for use on a specific computer on the fundamentals of aircraft combat survivability was prepared and developed specifically for aircraft operator's use. Fourth, in the development of capabilities study for the Weapons and Tactical Analysis Center (WEPTAC) at the Naval Weapons Center (NWC), a User's Manual and sample experiment were prepared. The sample experiment involved the use of P-3 aircraft in several scenarios. Fifth, in the survivability studies in conceptual design, reports were written on the development methodologies and computer programs for the assessment of aircraft survivability. Last, in the survivability assessment and computer graphics, pre- and post-processors for the existing computer programs used to assess aircraft combat survivability was developed. Particular emphasis was given to the introduction of interactive graphics capabilities to the program.

ELECTROHYDRODYNAMIC CONTROL OF FUEL INJECTION IN GAS TURBINE COMBUSTORS

Professors Biblarz and Miller are evaluating electrostatic modification of fuel spray patterns to allow the use of less expensive jet engine fuels. Spray characteristics of a T-56 aircraft gas turbine combustor have been modified electrodynamically. Various electrode configurations have been studied. An optical transmission technique without combustion has indicated that a centerline electrode charged up to 30kV is capable of producing large changes in fuel spray characteristics. The effects on combustion are being ascertained from the measurement of combustion products temperature. With 10kV, improvement has been noticed with various fuels in the fuel/rich and fuel/lean zones.

LDA INVESTIGATIONS AND APPLICATIONS OF MODERN CONTROL THEORY

Professor Collins has continued his research work on the measurement of instantaneous velocity profiles in turbomachinery and oscillatory flows. Using a DISA Interface time-differentiated velocity have been made. Instantaneous profiles for an oscillating flow still have to be
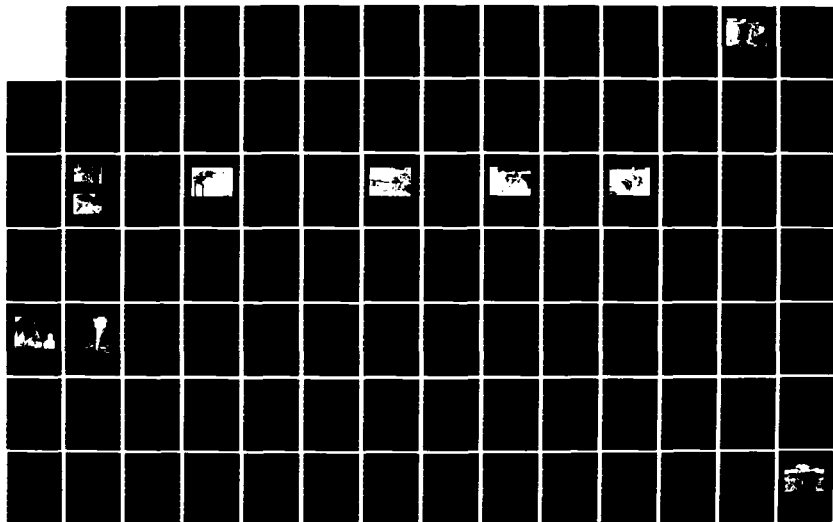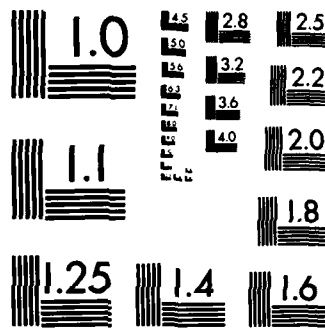
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

obtained. Time-keyed data in the transonic compressor is now possible. In another research area, his study of robust controllers with particular application to engine and flight and missile technology was completed.

FACULTY ASSISTANCE TO REVIEW NAVAL AIR DEVELOPMENT (NADC) RESEARCH PROGRAM

Professors Collins, Titus, Perkins and CDR Puccini assisted in the annual evaluation review of the Naval Air Development Research Programs. Final report of their evaluation was prepared.

ADVANCED INDIRECT FIRE SUPPORT (AIFs) TECHNOLOGY TO NAVAL MISSIONS

Under AIFs sponsorship, several contractors are investigating cannon-launched, ramjet-propelled guide for the U.S. Army. The work at the Naval Postgraduated School (NPS) is to examine the applicability of this technology to Navy missions.

Dr. Fuhs investigated ramjet-propelled projectiles using both solid and liquid fuels; determined range, time of flight, and impact velocity for surface warfare applications and investigated the use of cannon-launched guided projectiles in the AAW roles, including laser designation for terminal homing. There were two other projects, one in ramjet cannon-launched anti-satellite weapon, the other in the design of a spike (conical) lens using variable refractive lens.

FLOW CONTROL FOR LASER TURRETS

Dr. Fuhs has continued his experiment on the prevention of flow separation downstream of a laser turret. In the various experiments conducted, the result in the use of an especially small fairing size was proven adequate.

PROBE FOR PRESSURE ALTITUDE

Dr. Fuhs is trying to develop and verify the performance of a probe to measure pressure. A static pressure probe was tested to determine experimentally the feasibility of using the probe, as an integral part of a missile nose, to sense missile altitude. Several experiments were conducted at Mach 2.0 and Mach 1.51 and the result of these experiments was that the probe operates satisfactorily at Mach 1.51.

SPACECRAFT CONTAMINATION FROM LASER EXHAUST

On this fairly new project, initiated in the latter part of FY'82, Dr. Fuhs is trying to determine the flux of backscattered molecules when an open-cycle laser is fired from a spacecraft. Literature survey was made and preliminary screening of possible computer programs was initiated.

UNDERWATER SHAPED CHARGES

Dr. Fuhs' research project objectives are to experimentally investigate the physical phenomena involved in underwater shaped charges and to develop computer models. A series of tests were conducted and vast data were obtained. A computer program is being developed using a modified program for supersonic blunt body blow.

PILOT RESPONSE TO VIBRATION

Professor Layton has examined the effect of cockpit environment vibration of the tracking (piloting) ability of an aircraft pilot. Testing was made using Navy and Marine pilots in a vibrating simulator resulted in a disclosure of a degradation of tracking performance. This degradation was consequently eliminated.

HIGH ENERGY LASER SYSTEM SAFETY

Professor Layton's research objective is to provide technical support in the area of System Safety. Professor Layton conducted on-site investigations of the activities of the System Safety Section of the High Energy Laser Program and made recommendations including a development of a System Safety Management Plan. This plan was developed and Professor Layton did the final review.

INSPECTIONS TECHNIQUES FOR UNDERGROUND STEAM LINES

Professor Miller has continued to investigate and develop methods and techniques for activity level Public Works inspection of underground steam lines including sulphur hexaflcride leak detection field procedures; heat loss measurement field procedures, and overall procedures/guidelines manual. Techniques have been developed using sulphur hexaflouride to locate shell leaks. Field tests were made and a field manual section has been written. An instrumentation has been developed and currently being field-tested. This instrumentation would be used to directly measure heat loss from steam distribution lines. A draft field manual chapter for this work has been written.

SOLID FUEL RAMJET COMBUSTION

Professor Netzer has continued in the development of computer simulation of the combustion process, and in determining the effects of the combustor/inlet geometry and flow condition on the obtainable performance and on the occurrence of combustion pressure oscillation. Work has been completed on the two-dimensional model.

GAS TURBINE COMBUSTION AND TEST CELL EMISSIONS

Professor Netzer conducted an experiment to determine the effects of fuel additives and fuel composition on emitted particulate and NO_x levels.

Seven fuel additives were tested to investigate their effectiveness at reducing exhaust stack gas opacity in a turbojet test cell.

PARTICULATE BEHAVIOR IN SOLID PROPELLANT ROCKET MOTORS

Professor Netzer has continued his combustion study of composite solid propellants using holography, high-speed motion pictures, light-scattering measurements and postfire particle/collection/scanning electron microscopic examination. The immediate goal of the study is to evaluate the relative advantages and disadvantages of the different experimental techniques for obtaining two-phase flow characteristics within the combustion environment of a solid propellant grain.

A new two-beam system was developed. Particle diameter measurements have been successfully made at the exhaust and at the grain exit. Monochromatic illumination is currently being used for high-speed motion picture studies of strand burners.

COMPRESSOR TIP CLEARANCE EFFECTS

Dr. Shreeve is investigating the effects of changes in tip clearance on the performance of and flow fields within a multistage axial compressor with a view to proposing an improvement in the usual design procedure which ignores the gap.

A low speed three-stage axial compressor has been fitted with a single stage of "symmetrical" blading and first measurements of the performance map and internal flow profiles have been obtained. Work was concentrated on setting up instrumentation and procedures for the tip clearance. Corrections, and control of the boundary layer are currently being evaluated.

AXIAL COMPRESSOR/WAVE ROTOR STUDIES

Dr. Shreeve has conducted two separate studies: to complete the development and application of a new experimental technique to measure flow field from a high-speed compressor rotors, and to examine the technology and potential of wave rotor devices for propulsion applications.

The "Dual Probe Digital Sampling (DPDS)" technique was successfully applied to map the velocity field at the rotor exit. A Riemann Program for preliminary design of wave rotor cycles was implemented.

TRANSONIC COMPRESSOR INVESTIGATION

Dr. Shreeve and Dr. Heinemann are to provide the means for and to conduct careful experimental investigations required to improve in a fundamental way design and analysis methods used for transonic compressors.

A 450-HP single-stage axial transonic compressor and test rig were built. A range of instrumentation techniques have been developed and detailed measurements have been obtained in a model fan at the rotor tip. NASA computational programs for compressors and cascades have been converted for use at NPS, and a finite element through-flow program recently developed in-house. A review of tip clearance effects in compressors was also completed.

DEVELOPMENT OF A TRANSONIC COMPRESSOR MODEL

Dr. Shreeve is continuing their development of a small transonic axial air compressor model and to establish methods for measuring performance and flow behavior.

The development of the test compressor and test rig hardware is directly associated with the transonic compressor investigation project. Modifications were made to the drive turbine and a window was added to allow LDV measurements within the rotor. The off-design performance of the drive turbine was calculated.

VERY HIGH REACTION TURBINES

Dr. Shreeve is analytically and experimentally investigating the potential of two proposed very high reaction turbines of original design.

A turbine concept involving a simple, easily machined rotor geometry has been promoted. An analysis was completed of the potential of the prototype geometry and was programmed to allow variation of the available parameters. An apparatus to measure static torque of a detonative combustion turbine concept was built and will be tested.

DEVELOPMENT AND USE OF A CENTRIFUGAL DIFFUSER TEST DEVICE (CDTD)

Mr. Erwin is developing a satisfactory method for testing diffusers for centrifugal compressors and using the resulting facility to verify NASA computer codes.

A method of generating and controlling an axi-symmetric flow into a typical centrifugal diffuser arrangement was proposed. A apparatus to evaluate the technique and to perform controlled measurements with particular designs of diffuser vanes is being built and installed in the low speed cascade building.

NUMERICAL MODELING OF THE FLOW IN TRANSONIC AXIAL COMPRESESSORS

Dr. Eidelman and Dr. Shreeve are developing a computer which solves efficiently and accurately the transonic flow between the blades of a turbo-compressor. A code, based on the Godunov method, was developed for a body-fitted curvilinear coordinate system with multi-grid capability. A second variant of the code was also developed which uses a new second order accurate method. Various testing were made for these codes.

INVESTIGATION OF AEROELASTIC PHENOMENA IN TURBOMACHINES

Professor Platzer is compiling a comprehensive review of the unsteady aerodynamic/aeroelastic phenomena occurring in turbomachines, analyzing supersonic flow past oscillating blade cascades and completing the investigation of vane-excited jets for use in thrust augmenting ejectors.

Title: Aircraft Combat Survivability Studies

Investigator: R. E. Ball, Professor of Aeronautics

Sponsor: Naval Air Systems Command

Objective: To provide continuing technical support to AIR-5164,
                    the Combat Survivability Branch of the Naval Air
                    Systems Command. Progress was made on the following
                    projects this year:

                    a) Aircraft Survivabililty in a War-at-Sea Scenario

                    b) Survivability Considerations in the Marine Direct
                       Air Support Center (DASC) Operations

                    c) Preparation of a Survivability Self-Study Program
                       for Operators

                    d) Development of Capabilities for the WEPTAC at the
                       Naval Weapons Center (NWC)

                    e) Survivability Studies in Conceptual Design

                    f) Survivability Assessment and Computer Graphics

Summary: a) This project consists of an examination of the
                       survivability of naval aircraft in a war-at-sea
                       scenario.

                    b) This project involved the development of a
                       digital computer program to be used by the U. S.
                       Marines in their DASC operations to direct close
                       air support aircraft to their targets using the
                       most survivable routes. (Thesis No. 1 was
                       written for this project.)

                    c) This project consisted of the preparation of a
                       one-hour lecture and a self-study program for use
                       on the Apple Computer on the Fundamentals of
                       Aircraft Combat Survivability. The material was
                       developed specifically for use by aircraft
                       operators. (Thesis No. 2 was written for this
                       project.)

                    d) A User's Manual and sample experiment were
                       prepared for the Weapons and Tactical Analysis
                       Center (WEPTAC) for use at the Naval Weapons
                       Center (NWC). The sample experiment involved the
                       use of the P-3 in several scenarios.

e) This project involves the development of methodologies and computer programs for the assessment of aircraft survivability in the conceptual design phase. (Theses Nos. 3, 4, and 5 were completed this year.)

f) This project consists of the development of pre-and post-processors for the existing computer programs used to assess aircraft combat survivability. Particular emphasis is given to the introduction of interactive graphics capabilities to the program. (Thesis No. 6 was completed this year on this project.)

Theses Directed:

1. T. L. Dempsey, "TAP: A Microprocessor-based Program to Determine the Survivability of Close Air Support Aircraft," Master's Thesis, June 1982.

2. P. R. Seipt, "Aircraft Combat Survivability, A Systems Approach to Knowledge Transfer (Or, How to Sell ACS to Tactical Aircrews)," Master's Thesis, June 1982.

3. V. A. Schaffer, "Susceptibility Assessment for the Conceptual and Preliminary Design of Aircraft," Master's Thesis, June 1982.

4. N. P. Hesser, "The Development of an Interactive Computer Program for the Survivability Evaluation of Aircraft Conceptual Designs," Aeronautical Engineer's Thesis, June 1982.

5. D. R. Ferrell, "A Review and Analysis of Aircraft Vulnerability," Master's Thesis, September 1982.

6. E. R. Johns, "Creation of a Transportable Interactive User Interface for Improved AAA Simulation Program (P001)," Master's Thesis, June 1982.

Title: Faculty Assistance to Review Naval Air
                        Development (NADC) Research Programs

Investigators: D. J. Collins, Professor of Aeronautics;
                        H. A. Titus, Professor of Electrical Engineering;
                        A. J. Perkins, Associate Professor of Mechanical
                        Engineering; and CDR D. E. Puccini, U. S. Navy,
                        Instructor of Oceanography

Sponsor: Naval Air Development Center

Objective: To assist NADC in the annual evaluation
                        of its IR projects.

Summary: NADC was visited and review was conducted over a
                        five-day period. Final report was prepared.

Title: LDA Investigations and Applications
                        of Modern Control Theory

Investigator: D. J. Collins, Professor of Aeronautics

Sponsor: Naval Air Systems Command

Objectives: Measurement of instantaneous velocity profiles in
                        turbomachinery and oscillatory flows.

                        Study of robust controllers with particular
                        application to engine and flight and missile
                        technology.

Summary: Time differentiated velocity measurements
                        have been made using a DISA Interface.
                        Instantaneous profiles for an oscillating flow yet have
                        to be obtained. It is now possible to obtain time
                        keyed data in the transonic compressor. Work was
                        completed in the controls area.

Thesis Directed: E. Ohlmeyer, "Application of Optical Estimation and
                        Control Concepts to a Bank-to-Turn Missile,"
                        Master's Thesis, October 1982.

Title: Development and Use of a Centrifugal Diffuser
Test Device (CDTD)

Investigator: J. R. Erwin, Naval Air Systems Command Visiting
Research Professor in Aeronautics

Sponsor: NASA Lewis Research Center

Objective: To develop a satisfactory method for testing dif-
fusers for centrifugal compressors and to use the
resulting facility to verify NASA computer codes.

Summary: A novel method of generating and controlling an
axi-symmetric flow into a typical centrifugal
diffuser arrangement was proposed. An apparatus
to evaluate the technique and to perform con-
trolled measurements with particular designs of
diffuser vanes is being built and installed in
the low speed cascade building at the Turbo-
propulsion Laboratory. If the proposed tech-
nique for controlling swirl angle and for
controlling case and hub wall boundary layer
profiles is successful, a second smaller rig
with transonic flow capability will be built
in the high speed building while code verifi-
cation measurements are made on the low speed
model.
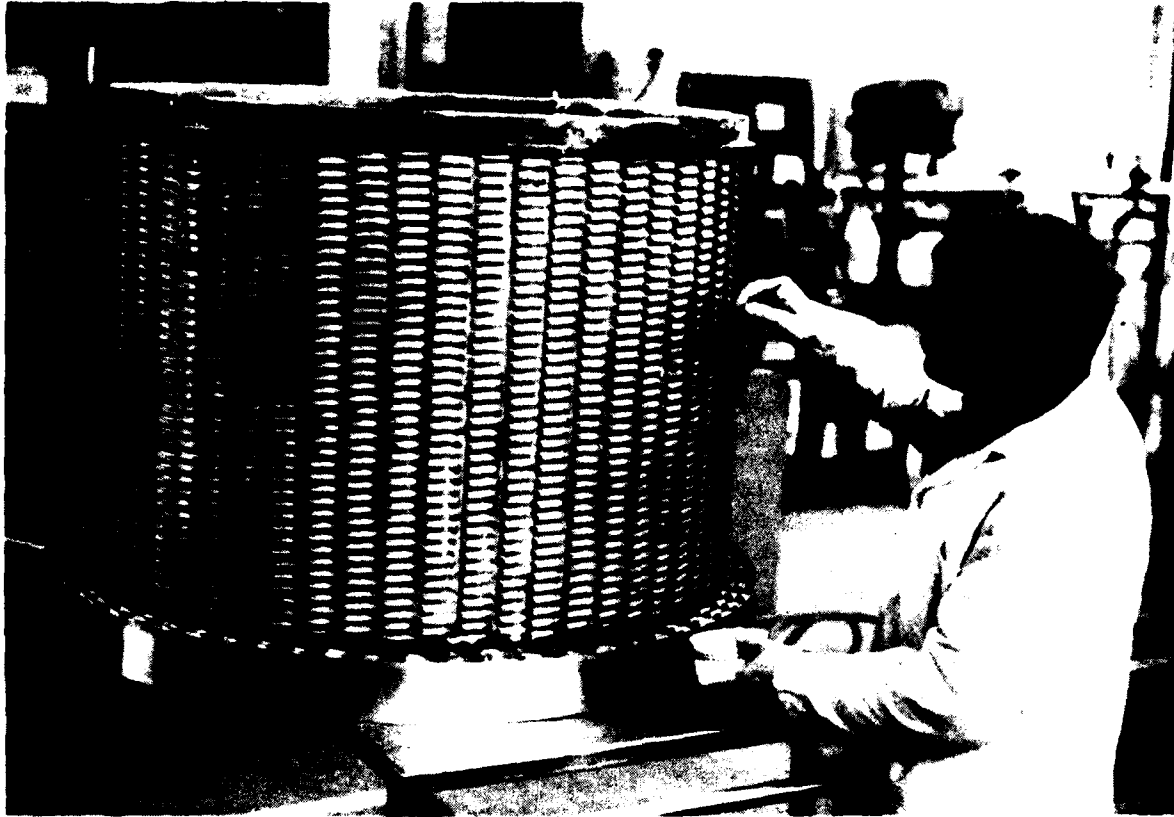
RAY PHILLIPS MAKES FINISHING TOUCHES TO SWIRL-GENERATING VANES FOR THE CENTRIFUGAL DIFFUSER TEST DEVICE.

Title: Application of Advanced Indirect Fire Support (AIFS)
                    Technology to Naval Missions

Investigators: Allen E. Fuhs, Distinguished Professor of Aeronautics
                    Dr. Oded Amichai, Associate Investigator
                    Professor Kenji Imai, Associate Investigator

Sponsor: Defense Advanced Research Projects Agency, Tactical
                    Technology Office.

Objective: Under AIFS sponsorship, several contractors are
                    investigating cannon-launched, ramjet-propelled guide
                    projectiles for U. S. Army 155mm. The work at the
                    Naval Postgraduate School (NPS) is to examine Navy
                    missions for which the technology is applicable.
                    FY'82 was the third year of a continuing effort;
                    funding has been provided for FY'83.

Summary: The counterpart to AIFS in the U. S. Army and U. S.
                    Marine Corp is OTH in the U. S. Navy. Ramjet
                    propelled projectiles were investigated using both
                    solid and liquid fuels. Range, time of flight, and
                    impact velocity were determined for surface warfare,
                    SuW, applications. Also, the use of cannon-launched
                    guided projectiles in the AAW role was investigated
                    including laser designation for terminal homing. A
                    special project was devoted to a ramjet,
                    cannon-launched anti-satellite weapon, i.e., a
                    16-inch ASAT. Another project within the scope of the
                    research involved design of a spike (conical) lens
                    using a variable refractive index.

Publications: K. Imai, "Solid Body Equations to Calculate the
                    Trajectory of a Ramjet," NPS Contractor's Report,
                    NPS67-82-001CR, March 1982.

                    O. Amichai, "Performance of Solid Fuel Ramjet Guide
                    Projectile for U. S. Navy 5"/54 Gun System," NPS
                    Contractor's Report, NPS67-82-002CR, March 1982.

                    O. Amichai, "Sharp Nose Lens Design Using Refractive
                    Index Gradient," NPS Contractor's Report,
                    NPS67-82-003CR, June 1982.

Theses Directed: J. J. Natale, "16-Inch Gun-Launched, Anti-Satellite Weapons," <u>Master's Thesis</u>, June 1982.

H. M. Carr, "Sharp Nose Lens Design Including Skew Rays," <u>Master's Thesis</u>, September 1982.

Patent Application: A. E. Fuhs, "Spike Lens Design Using Gradient Refractive Index," Applied 21 July 1982, Navy Case No. 66,954.

Title: Flow Control for Laser Turrets

Investigator: Allen E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Air Force Weapons Laboratory

Objective: To demonstrate experimentally the prevention of flow separation downstream of a laser turret.

Summary: Some laser turrets are blunt bodies extending from the aircraft fuselage. Flow separation occurs on the downstream side of the turret causing a region of intense turbulence. The turbulence causes severe degradation of the laser beam. By using a hollow fairing on the downstream side of the turret and by suction through the fairing, the flow can be maintained quiescent. An especially small fairing size was proven adequate in the experiments conducted during FY'82. The research is a continuing effort; AFWL has funded research at NPS for more than a decade.

Publication: J. R. Schonberger, A. E. Fuhs, and A. M. Mandigo, "Flow Control for an Airborne Laser Turret," Journal of Aircraft, Vol. 19, (1982), pp. 531-537.

Conference   J. R. Schonberger, A. E. Fuhs, and A. M. Mandigo,
Presentation: "Flow Control for an Airborne Laser Turret," AIAA Aircraft Systems Meeting, Dayton, OH, August 1982, (This presentation was the basis for the Journal of Aircraft article.)

Theses Directed: L. E. Penix, "Flow Control About an Airborne Laser Turret," Master's Thesis - Engineering Science, June 1982.

                 J. E. Burd, "Flow Control for a High Energy Laser Turret using Trapped Vortices Stabilized by Suction," Master's Thesis, December 1981.

                 D. A. Rippel, "Airborne Laser Turret Flow Control: A Parametric Study of Wind Tunnel Model Conditions," Master's Thesis, December 1981.

Title: Probe for Measuring Pressure Altitude

Investigator: Allen E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Naval Weapons Center

Objective: To develop and verify experimentally the performance of
                   a probe to measure pressure.

Summary: A static pressure probe was tested to determine
                   experimentally the feasibility of using the probe, as
                   an integral part of a missile nose, to sense missile
                   altitude. Experiments were conducted at Mach 2.0 and
                   Mach 1.51. At Mach 2.0, the static pressure probe will
                   perform within altitude specifications of 25,000 feet
                   $\pm$ 2,000 feet at angles-of-attack ranging from -8 to
                   $\mp$8 degrees. For angle of attack less than 6 degrees,
                   the probe provides a measurement of pressure
                   equivalent to a 900 altitude error. The probe
                   operates satisfactorily at Mach 1.51.

Conference   K. D. Tillotson and A. E. Fuhs, "Analysis and Wind
Presentation: Tunnel Tests of a Probe Used to Sense Altitude Through
                   Measurement of Static Pressure," AIAA Paper No.
                   82-1361, presented at the AIAA Atmospheric Flight
                   Mechanics Conference, San Diego, CA, 10-12 August
                   1982.

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Title: Spacecraft Contamination from Laser Exhaust

Investigator: Allen E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Defense Advanced Research Projects Agency

Objective: To determine the flux of backscattered molecules when
                    an open-cycle laser is fired from a spacecraft.

Summary: The project was initiated late in FY'82 with several
                    man days effort to conduct a literature survey. Also
                    a prelimininary screening of possible computer
                    programs was initiated. The main activity will occur
                    in FY'83 and subsequent years.

Title:	Underwater Shaped Charges
Investigator:	Allen E. Fuhs, Distinguished Professor of Aeronautics
Sponsor:	Naval Surface Weapons Center
Objective:	The project has two objectives as follows:

Objective (continued):

1. To experimentally investigate the physical phenomena involved in underwater shaped charges.

2. To develop computer models which are consistent with observations.

Summary: Penetration of the metal jet from an underwater shaped charge generates a vapor cavity and a bow shock wave. The metal jet penetrates supersonically relative to the water causing intense shock waves. Under certain circumstances, the metal jet reacts vigorously with the water releasing considerable chemical energy. A series of tests were conducted at NSWC/WOL. A vast amount of data were obtained some of which remains to be digested. A computer program is being developed using a modified program developed by NASA Ames Research Center for supersonic blunt body flow.

Publication: A. E. Fuhs, "Computer Program for Calculating Hydrodynamic Properties of Shock Waves in Sea Water," NPS Technical Report, NPS67-82-001, February 1982.

Conference Presentation: A. E. Fuhs, "Metal Combustion in Steam," U. S. Navy Warhead Meeting, Los Alamos, NM, 14-16 December 1981. (Published by NSWC/WOL in a compilation of papers.)

Thesis Directed: J. B. Strott and J. A. Buck, "Underwater Shaped Charges. I. Experimental Data," Master's Thesis - Engineering Science, June 1982.

Title: High Energy Laser System Safety

Investigator: Donald M. Layton, Professor of Aeronautics

Sponsor: Naval Sea Systems Command

Objective: To provide technical support in the area of System
                    Safety to the High Energy Laser Program of the
                    Directed Energy Project Office.

Summary: On-site investigations of the activities of the
                    System Safety section of the High Energy Laser
                    Program were conducted. Recommendations were made,
                    including that for the development of a System Safety
                    Management Plan. Such a plan was developed by this
                    office and reviewed by the investigator.

Title: Pilot Response to Vibration

Investigator: Donald M. Layton, Professor of Aeronautics

Sponsor: None

Objective: To examine the effect of cockpit environment
                    vibration of the tracking (piloting) ability of an
                    aircraft pilot.

Summary: Testing of Navy and Marine pilots in a vibrating
                    simulator disclosed a degradation of tracking
                    performance at a vibration frequency of about 25 to 30
                    Hertz. This degradation was not only eliminated, but
                    an actual cues increase in tracking scores was noted
                    when aural data were made available to the pilot.

Thesis Directed: Michael Wayne Mentas, "A Simulator Evaluation of Pilot
                    Response to Low Frequency Aircraft Vibration with
                    Audio Feedback," Master's Thesis, March 1982.

Title:	Electrohydrodynamic Control of Fuel Injection in Aircraft Gas Turbines
Investigators:	J. A. Miller, Associate Professor of Aeronautics and O. Biblarz, Associate Professor of Aeronautics
Sponsor:	Naval Air Systems Command
Objective:	To determine means of electrohydrodynamic control of spray characteristics of aircraft gas turbine fuel injectors to enable high combustion efficiency operation with a wide variety of hydrocarbon fuels.

Summary:	Two techniques have been developed to study the effects of electrostatic fields on the characteristics of fuel injector spray fields. In one technique optical absorption of laser light is used to match spray characteristics of different fuels, a measure of droplet size distribution and spray dispersion. Results of sprays from a T-56 injector nozzle and various fuels indicate substantial spray characteristic modification can be achieved with electrostatic accelerating potentials of 10-30 kilovolts-voltages typical of spark plug systems. In the second evaluative technique a T-56 burner can has been fitted with several designs of electrostatic elements and the modification and optimization of combustion efficiency with various fuels including JP-4, JP-5 and marine grade diesel has been achieved. A problem of electrical breakdown occasioned by the immersion of the electrostatic elements in the ionized combustion gases is expected to be overcome by redesign of the electrostatic elements and their deployment.

Theses Directed:	L. L. Todd, "Design of an Apparatus for the Study of Electrostatic Effects on Gas Turbine Fuel Sprays and Combustion Efficiency," Master's Thesis, December 1981.
	J. R. Logan, "Electrohydrodynamic Spraying of Aviation Fuels in a Gas Turbine, Master's Thesis, June 1982.
	R. J. Laib, "Design of an Apparatus for the Study of Electrohydrodynamic Control of Spray from Fuel Injectors in Gas Turbines," Aeronautical Engineer's - Thesis, September 1982.

Title: Electrohydrodynamic Control of Fuel Injection in Gas
                      Turbine Combustors

Investigators: J. A. Miller, Associate Professor of Aeronautics and
                      O. Biblarz, Associate Professor of Aeronautics

Sponsor: Naval Air Systems Command

Objective: A program is in progress to evaluate the merits of
                      electrohydrodynamically - controlled fuel injection
                      for gas turbine combustors. Fuel injection spray
                      characteristics are being studied with an optical
                      transmission technique and the effects on combustion
                      are being evaluated from measurements of combustion
                      product temperatures. The goal of this program is to
                      evolve practical means of using electrostatic
                      elements within the combustion chamber to control
                      fuel spray characteristics and thus optimize
                      combustion efficiency for a variety of gas turbine
                      fuels.

Summary: A T-56 aircraft injector has been employed in the
                      spray characteristics investigation and a T-56
                      injector and combustion can liner have been
                      incorporated into a combustion apparatus.
                      Preliminary results indicate that a centerline
                      electrode charged with voltages typical of spark
                      plugs, (30kV), is capable of producing large charges
                      in fuel spray characteristics and it has been
                      possible with this technique to match the spray
                      characteristic of JP-5 to those of the design fuel,
                      JP-4, over the operating envelope of the injector.
                      Some practical difficulties in maintaining electrode
                      voltage in the presence of ionizing flame fronts has
                      been encountered and a development program to
                      overcome this difficulty is underway. Additionally,
                      studies are being conducted to better understand the
                      effects of electrostatic fields on spray
                      characteristic modification and the subsequent
                      implications to the burning process and combustion
                      efficiency.

Thesis Directed: R. J. Laib, "Design of an Apparatus for the Study of
                        EHD Control of a Spray from Fuel Injectors in a Gas
                        Turbine," Aeronautical Engineer's Thesis, October 1982.

                        J. M. Logan, "Electrohydrodynamic Spraying of
                        Aviation Fuels in a Gas Turbine," Master's Thesis,
                        June 1982.

Patent Applications: O. Biblarz, J. A. Miller, and R. J. Laib, "EHD
                        Control of Fuel Injection in Gas Turbines," Navy Case
                        No. 65,213.

Title: Inspection Technique for Buried Steam Distribution
                    Lines

Investigator: J. A. Miller, Associate Professor of Aeronautics

Sponsor: Naval Civil Engineering Laboratories

Objective: Investigate and develop methods and techniques for
                    activity level public works inspection of underground
                    steam lines including development of (1) sulphur
                    hexaflouride leak detection field procedures; (2)
                    heat loss measurement field procedures; and (3)
                    overall procedures/guidelines manual.

Summary: Techniques have been developed which enable rapid
                    location of insulation shell leaks in direct burial
                    steam lines employing sulphur hexaflouride, a
                    non-reactive electronegative gas and an ion-capture
                    detector. Field tests have substantiated the
                    practicality of the procedure and a field manual
                    section has been written. Additionally,
                    instrumentation has been developed to allow direct
                    measurement of heat loss from steam distribution
                    lines. This equipment is currently in the field test
                    phase. Successful field tests have been carried out
                    in Norfolk, VA and are scheduled for Pensacola, FL.
                    A draft field manual chapter for this work has been
                    written.

Publication: J. A. Miller, "The Detection of Leaks in Buried Pipes
                    Using Sulphur Hexaflouride as a Tracer Gas,"
                    Transactions of the American Society of Mechanical
                    Engineers, Journal of Engineering for Power
                    (forthcoming).

Thesis Directed: W. Neboshynsky, "Field Inspection Techniques for
                    Buried Steam Distribution Lines," Master's Thesis,
                    June 1982.

Title:	Effects of Smoke Suppressant Fuel Additives on Gas Turbine Combustion and Test Cell Emissions
Investigator:	D. W. Netzer, Professor of Aeronautics
Sponsor:	Naval Air Propulsion Center
Objective:	Experimentally determine the effects of fuel additives and fuel composition on emitted particulate and NO_x levels.

Summary:

Seven fuel additives were tested to investigate their effectiveness at reducing exhaust stack gas opacity in a turbojet test cell. Exhaust particle sizes and mass concentrations were determined at the engine and stack exhausts using measurements of light transmittance at three frequencies. Particle samples were also collected at the engine exhaust and measured with a scanning electron microscope to verify the optical technique. Nitrous oxide emissions were measured at the test cell stack exhaust.

Four of the additives tested were found effective at reducing stack exhaust opacity and particulate mass concentration. None of the additives had any measurable effect on particle diameters. No meaningful changes in particle size or mass occurred between the engine and stack exhausts. The optical technique for determining particle size was verified effective using the scanning electron microscope. No additive had any significant effect on nitrous oxide production.

Publications:

D. W. Thornburg, T. R. Darnell and D. W. Netzer, "An Investigation of the Effects of Smoke Suppressant Fuel Additives on Engine and Test Cell Exhaust Gas Opacities," NPS Technical Report, NPS67-82-004, May 1982.

J. R. Bramer and D. W. Netzer, "An Investigation of the Effectiveness of Smoke Suppressant Fuel Additives for Turbojet Applications," NPS Technical Report, NPS67-82-13, September 1982.

Theses Directed: D. W. Thornburg, "An Investigation of Engine and Test
Test Cell Operating Conditions on the Effectiveness
of Smoke Suppressant Fuel Additives,"
<u>Master's Thesis</u>, December 1981.

J. R. Bramer, "An Investigation of the Effectiveness of
of Smoke Suppressant Fuel Additives for Turbojet
Applications," <u>Master's Thesis</u>, September 1982.

Title:	Particulate Behavior in Solid Propellant Rocket Motors
Investigator:	D. W. Netzer, Professor of Aeronautics
Sponsor:	Air Force Rocket Propulsion Laboratory
Objective:	Holography, high-speed motion pictures, light scattering measurements and postfire particle collection/scanning electron microscopic examination are to be used to study the combustion of composite solid propellants. The immediate goal of the study is to evaluate the relative advantages and disadvantages of the different experimental techniques for obtaining two-phase flow characteristics within the combustion environment of a solid propellant grain.

Summary:	A new two-beam system was developed to use diffractively scattered laser power measurements for determination of the changes in particle diameter across the exhaust nozzle of a solid propellant rocket motor. Particle diameter measurements have been successfully made at the exhaust and at the grain exit but the presence of binder/inhibitor in the gas flow has limited accuracy to date.

Monochromatic illumination is currently being used for high speed motion picture studies of strand burners to eliminate recording of the flame, envelopes that exist around the aluminum/aluminum oxide particulates. |

Publication:	S. G. Karagounis, V. D. Diloreto, T. R. Gillespie II, E. Dubrov, P. J. Hickey and D. W. Netzer, "An Investigation of Experimental Techniques for Obtaining Particulate Behavior in Metallized Solid Propellant Combustion," Air Force Rocket Propulsion Laboratory Report, AFRPL-TR-82-051, July 1982.
Conference Presentation:	D. W. Netzer and S. G. Karagounis, "An Investigation of Particulate Behavior in Solid Propellant Rocket Motors," 18th JANNAF Combustion Meeting, Jet Propulsion Laboratory, Pasadena, CA, 19-23 October 1981.

Theses Directed: T. R. Gillespie, "Holographic Investigation of Solid Propellant Particulates," Master's Thesis - Engineering Science, December 1981.

R. G. Cramer, "Particle Size Determination in Small Solid Propellant Rocket Motors Using the Diffractively Scattered Light Method," Aeronautical Engineer's Thesis, October 1982.

D. E. Faber, "Holographic Investigation of Solid Rocket Propellant Combustion," Master's Thesis, December 1982.

M. A. McInnis, "Holographic Reconstruction Methods for Optimum Resolution of Combustion Phenomena," Master's Thesis, December 1982.

R. J. Edington, "Monochromatic High Speed Motion Picture Studies of Solid Rocket Propellant Combustion," Master's Thesis, March 1983.
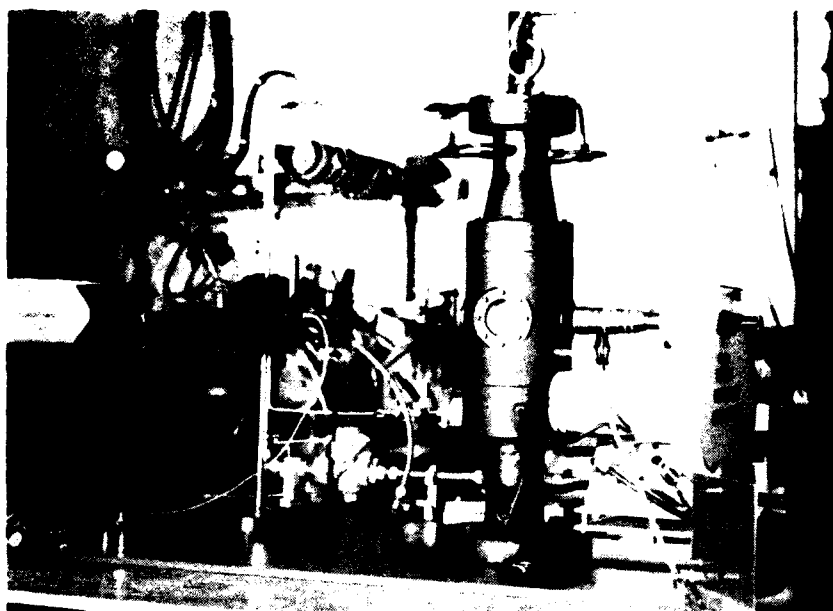
COMBUSTION BOMB FOR HIGH SPEED MOTION PICTURE
STUDIES OF SOLID PROPELLANT COMBUSTION.
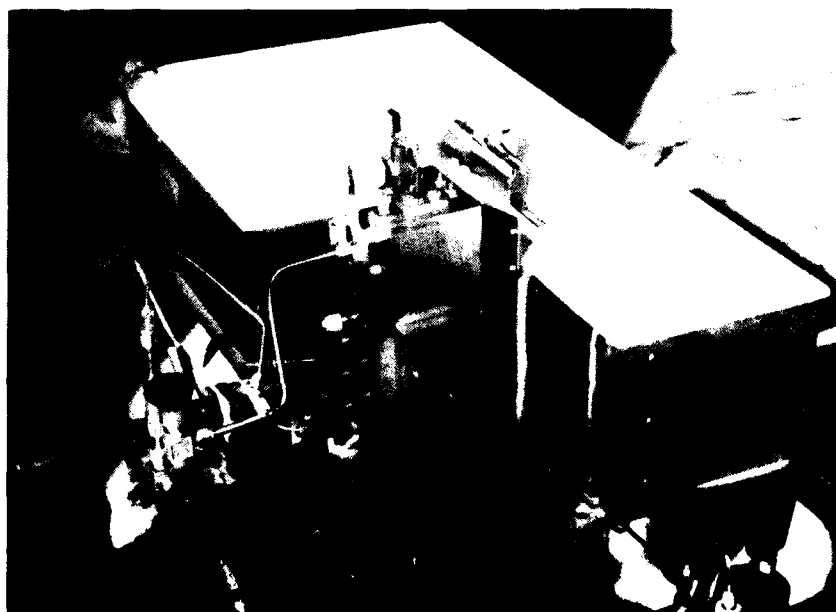
TWO-DIMENSIONAL SOLID PROPELLANT ROCKET
MOTOR AND HOLOCAMERA FOR HOLOGRAPHIC STUDY
OF COMBUSTION PHENOMENA.

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Title:	Solid Fuel Ramjet Combustion
Investigators:	D. W. Netzer, Professor of Aeronautics
Sponsor:	Naval Weapons Center
Objectives:	1. To continue development of computer simulation of the combustion process.
	2. To determine the effects of combustor/inlet geometry and flow condition on the obtainable performance and on the occurrence of combustion pressure oscillations.
Summary:	Work has been completed on the two-dimensional model. Current efforts are directed at adaptation of the Air Research 3-D code to the SFRJ combustor geometry.
Publication:	M. E. Metochianakis and D. W. Netzer, "Modeling Solid Fuel Ramjet Combustion Including Radiation Heat Transfer to the Fuel Surface," Journal of Spacecraft and Rockets, (forthcoming).
Conference Presentations:	D. W. Netzer, M. E. Metochianakis, W. V. Goodwin, and U. Katz, "Combustion Behavior in Solid Fuel Ramjets," 18th JANNAF Combustion Meeting, Jet Propulsion Laboratory, Pasadena, CA, 19-23 October 1981.
	D. W. Netzer, "Solid Fuel Ramjet Fuel Evaluations," NAVAIRSYSCOM Workshop on High Energy Hydrocarbon Fuels, Naval Postgraduate School, Monterey, CA, 17-18 November 1981.
Thesis Directed:	G. A. Begley, Jr., "Flowrate Effects on the Performance of Solid Fuel Ramjet Combustors," Master's Thesis, December 1982.
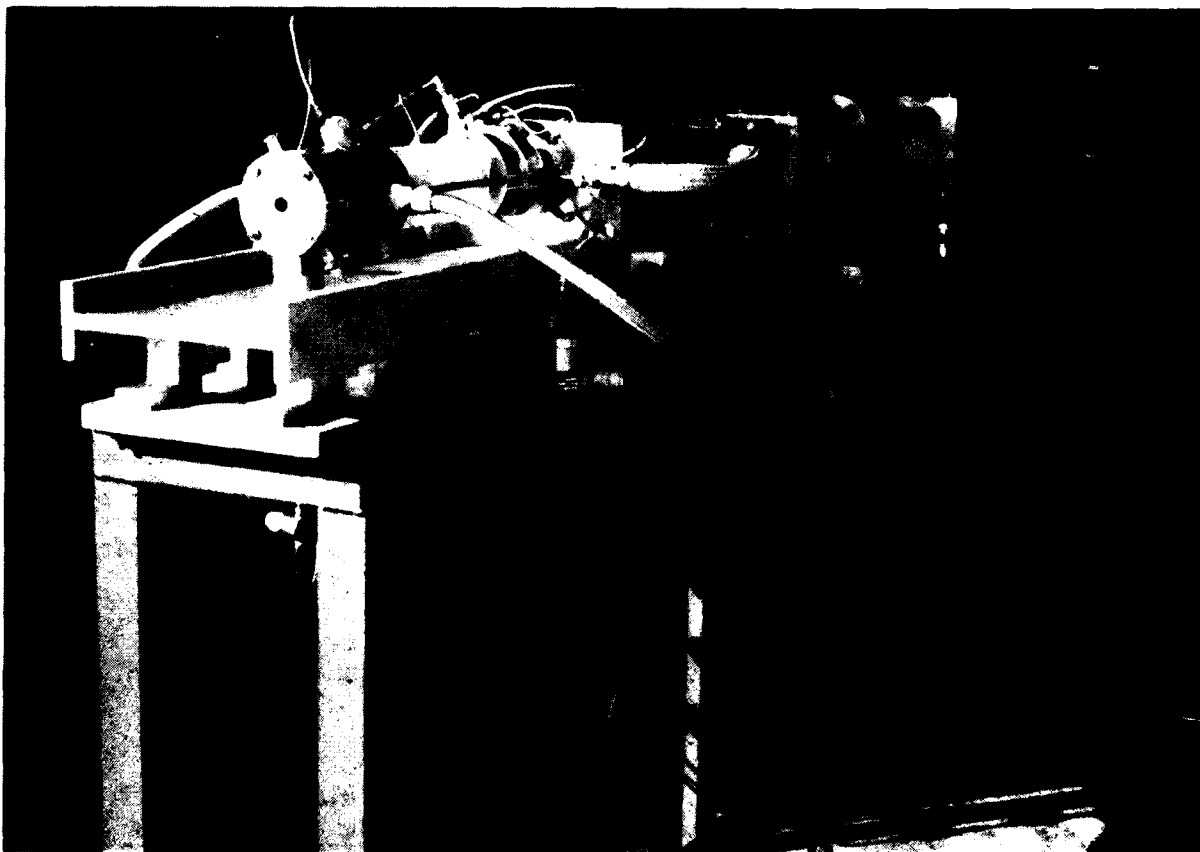
SOLID FUEL RAMJET ON TEST STAND.

Title:	Investigation of Aeroelastic Phenomena in Turbomachines
Investigator:	M. F. Platzer, Professor of Aeronautics
Sponsor:	Naval Air Systems Command
Objective:	To compile a comprehensive review of the unsteady aerodynamic/aeroelastic phenomena occurring in turbomachines, to analyze supersonic flow past oscillating blade cascades and to complete the investigation of vane-excited jets for use in thrust augmenting ejectors.
Summary:	Work was begun on the formulation of the basic outline for the AGARD Manual on Aeroelasticity in Turbomachines. A number of authors have agreed to this outline and are working on the initial chapters. Hui's theory was applied to oscillating supersonic wings (Ref. 1) and the extension to oscillating cascades was formulated. Tests of the vane-excited jet were completed and a paper on this work is in preparatation. Also, a review of the transonic blade flutter problem was published (Ref. 2).
Publications:	1. W. H. Hui, M. F. Platzer, E. Youroukos, "Oscillating Supersonic/Hypersonic Wings at High Incidence," AIAA Journal, Vol. 20, No. 3, pp. 299-304, March 1982.

2. M. F. Platzer, "Transonic Blade Flutter: A Survey of New Developments," The Shock and Vibration Digest, Vol. 14, No. 7, pp. 3-8, July 1982. |

Title: Axial Compressor/Wave Rotor Studies

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion
                    Laboratory Department of Aeronautics

Sponsor: Office of Naval Research

Objective: Two separate studies are involved: (i) to complete
                    the development and application of a new experimental
                    technique to measure the flow field from a high speed
                    compressor rotor, and (ii) to examine the technology
                    and potential of wave rotor devices for propulsion
                    applications.

Summary: The "Dual Probe Digital Sampling" (or DPDS) techniques
                    was successfully applied to map the velocity field at
                    the rotor exit. With a second generation system of
                    smaller probes it was shown from the redundancy
                    inherent in the technique that the measurements were
                    valid outside the unsteady rotor wakes and at the wake
                    center. Methods to resolve the unknown uncertainty in
                    regions of wake gradients and comparisons with LDV
                    measurements are yet to be obtained. A Riemann
                    program for preliminary design of wave rotor cycles
                    was implemented.

                    The status of knowledge and methods for analyzing
                    flows in wave rotors have been reviewed and will soon
                    be reported.

Publications: R. P. Shreeve and F. Neuhoff, "Measurements of the
                    Flow from a High Speed Compressor Rotor Using a Dual
                    Probe Digital Sampling (DPDS) Technique," NPS
                    Technical Report, NPS67-82-010, September 1982. (To
                    be presented as a paper at the ASME 28th International
                    Gas Turbine Conference, Phoenix, Arizona, March 27-31,
                    1983.)

                    S. Eidelman, A. Mathur, R. P. Shreeve and J. R. Erwin,
                    "Application of Riemann Problem Solvers to Wave
                    Machine Design," submitted to AIAA Journal for publi-
                    cation, August 1982.
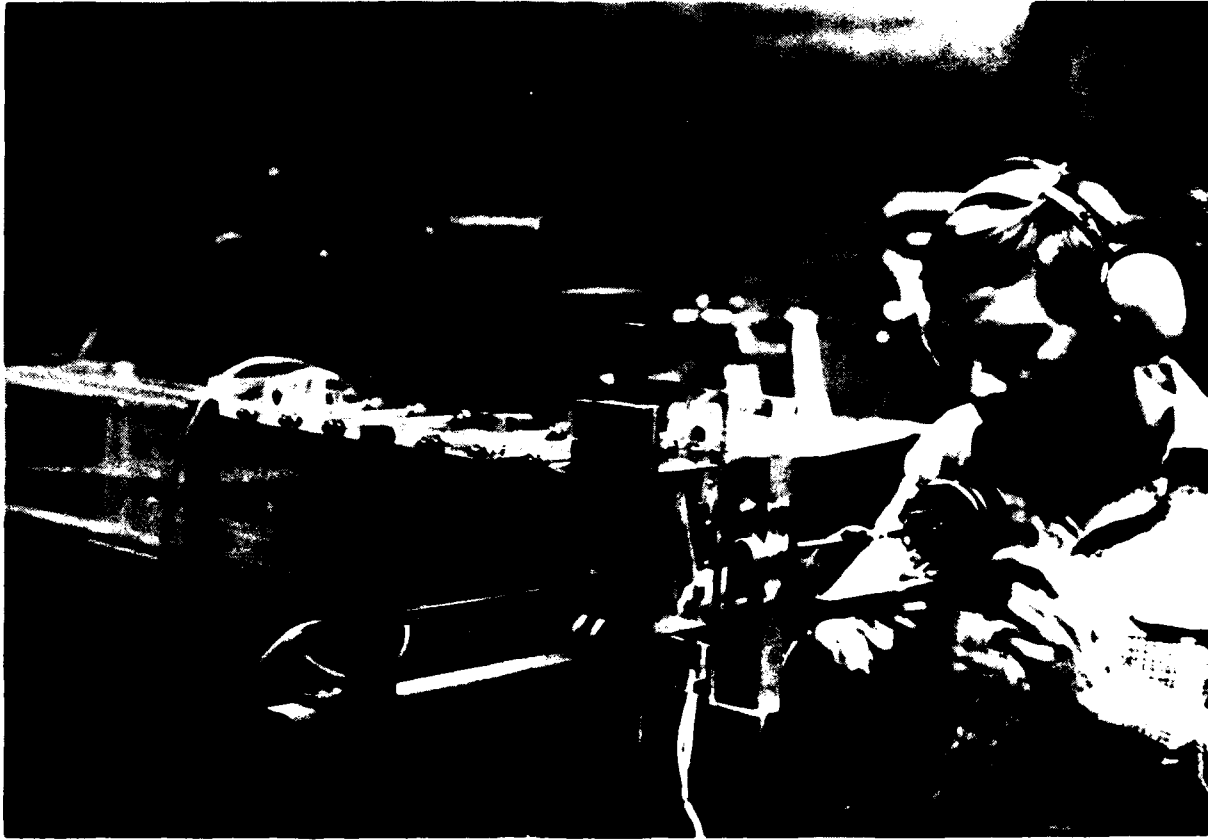
FREDRICK NEUHOFF PERFORMS CALIBRATION OF PROBES FOR DUAL PROBE
DIGITAL SAMPLING TECHNIQUE.

Title: Cascade Studies of Flows Through Compressor
                    Bladings

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion
                    Laboratory, Department of Aeronautics

Sponsor: NASA Lewis Research Center

Objective: To obtain data using a large (60" x 10") subsonic
                    cascade wind tunnel to verify computational codes
                    used in optimizing designs of controlled diffusion
                    (CD) blading.

Summary: The adjustable inlet guide vane (IGV) section
                    controlling the inlet air angle to the test cascade
                    was rebuilt to have blades at 1 inch instead of 2
                    inch intervals. Turning vanes were added to the
                    plenum to reduce flow unsteadiness. Uniformity of
                    the flow into the test cascade was found to be
                    excellent. Tests to repeat measurements on
                    reference DCA blading are in progress and CD blade
                    set has been delivered. NASA programs QSONIC and
                    TSONIC have been implemented and results confirm
                    DCA blade pressure distributions.

Publication: D. M. McEligot, "Uniform Inlet Conditions for the
                    NPS Subsonic Cascade Wind Tunnel," NPS Technical
                    Report, NPS67-81-019PR, December 1981.

Thesis Directed: W. D. Molloy, Jr., "Preliminary Measurements and
                    Code Calculations of Flow Through a Cascade of DCA
                    Blading at a Solidity of 1.67," Master's Thesis,
                    June 1982.

ENGINEERS DISCUSS BLADING DESIGNS TESTED IN THE SUBSONIC CASCADE WIND TUNNEL.

Title: Compressor Tip Clearance Effects

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion
                    Laborator, Department of Aeronautics

Sponsor: NPS Foundation Research Program

Objective: To investigate the effects of changes in tip clear-
                    ance on the performance of and flow fields within a
                    multistage axial compressor with a view to
                    proposing an improvement in the usual design
                    procedure which ignores the gap.

Summary: A 36 inch O.D. low speed three stage axial compres-
                    sor having a 7.2 inch cylindrical flow path has been
                    fitted with a single stage of "symmetrical" blading
                    and first measurements of the performance map and
                    internal flow profiles have obtained. Work has
                    concentrated on setting up instrumentation and
                    procedures for the tip clearance study. The flow
                    from the IGV's was found to be underturned over the
                    outer 30% of the blade in the presence of a thick
                    inlet boundary layer. Corrections, and control of
                    the boundary layer are being evaluated before
                    additional stages are added and tip clearance
                    variations are effected. (Procedures for blading
                    manufacture and machining for tip gap control were
                    developed in early phases of the study.)

Publication: J. L. Waddell, "Multi-stage Compressor--Flow Losses
                    in Throttle Screens and Plates," NPS Turbopropulsion
                    Laboratory Technical Note, TPL TN 82-01, February
                    1982.

Thesis Directed: J. L. Waddell, "Evaluation of the Performance and
                    Flow in an Axial Compressor," Master's Thesis, June
                    1982.
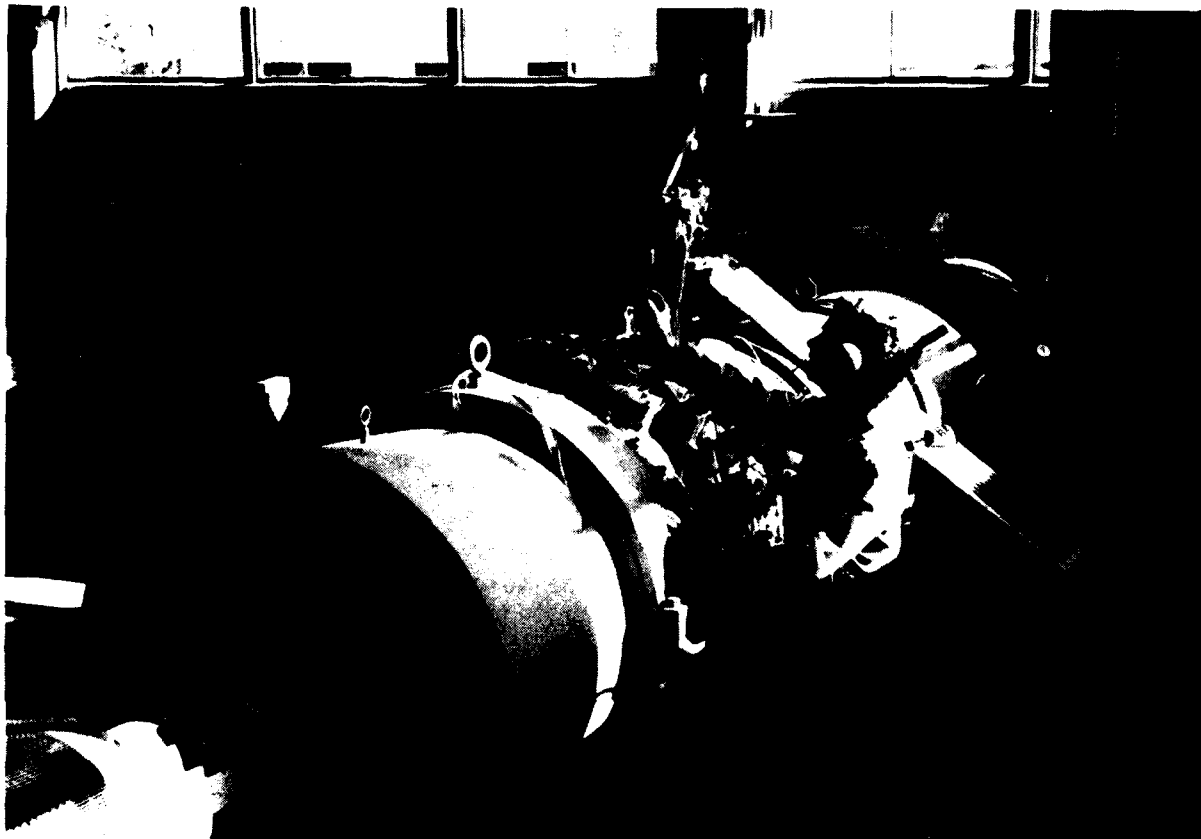
ENGINEER ADJUSTING FLOW PROBES FOR DUAL PROBE DIGITAL SAMPLING
TECHNIQUE.

Title: Development of a Transonic Compressor Model

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion
                   Laboratory, Department of Aeronautics

Sponsor: Naval Air Systems Command

Objective: To continue development of a small transonic axial
                   air compressor model and establish methods for
                   measuring performance and flow behavior.

Summary: Directly associated with the project "Transonic
                   Compressor Investigations," is the development of
                   the test compressor and test rig hardware to design
                   speeds of 30,460 RPM. Modifications were made to
                   the drive turbine to protect the rotor in the event
                   of bearing failure and a window was added to allow
                   LDV measurements within the rotor. The off-design
                   performance of the drive turbine was calculated to
                   allow an assessment of the capability to test
                   various compressor stage designs.

Publications: J. A. Ferguson, "Verification of a Single Stage
                   Axial Turbine Performance Prediction Program for
                   the HP-21MX Computer System," NPS Turbopropulsion
                   Laboratory Technical Note, TPL TN 82-02, May 1982.

                   F. Neuhoff, "Computer Software for the Calibration
                   of Pneumatic and Temperature Probes," NPS Turbo-
                   propulsion Laboratory Technical Note, TPL TN 82-03,
                   September 1982.

Title:	Numerical Modeling of the Flow in Transonic Axial Compressors
Investigators:	Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory, and S. Eidelman, NRC Postdoctoral Research Associate
Sponsor:	NPS Foundation Research Program
Objective:	To develop a computer code which solves efficiently and accurately the transonic flow between the blades of a turbocompressor.

Summary: A code, based on the Godunov method, was developed for a body-fitted curvilinear coordinate system with multi-grid capability. In this code, the Euler equations are solved in Cartesian coordinates and Riemann problems are solved in directions normal to the boundaries of the computational mesh. A second variant of the code was developed which uses a new second order accurate method of Collela. Comparison of the predictions of both methods with an analytical solution of the shock wave problem showed good accuracy for both codes. The second order accurate method had very sharp shock wave resolution over only two grid points. Testing the codes on the problem of the flow in a channel with a circular arc "bump" gave good results for the supersonic case. Testing for subsonic and transonic flow is proceeding. Since the approach uses the unsteady equations, the program can be applied with unsteady boundary conditions. A preliminary modeling of the opening of a wave rotor cell showed that it is possible to use the developed program for modeling two-dimensional effects in wave engines.

Publications: S. Eidelman, "A Method of Calculation of the Critical Energy for Direct Initiation of Unconfined Detonation," Combustion Science and Technology, Vol. 44, 1982, p. 444.

S. Eidelman, A. Mathur, R. Shreeve and J. Erwin, "Application of Riemann Problem Solvers to Wave Machine Design," submitted for publication to AIAA Journal, 1982.

Title:	Transonic Compressor Investigations
Investigator:	Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory, Department of Aeronautics
Sponsor:	Naval Air Systems Command
Objective:	To provide the means for and to conduct careful experimental investigations required to improve in a fundamental way design and analysis methods used for transonic compressors.
Summary:	A 450 HP single stage axial transonic compressor and test rig were built and are used with computer-based instrumentation and data acquisition techniques to obtain experimental measurements of compressor flow fields and flow phenomena. A range of instrumentation techniques has been developed and detailed measurements have been obtained in a model fan stage with DCA blading operating to sonic relative Mach numbers at the rotor tip. NASA computational programs for compressors and cascades have been converted for use at NPS, and a finite element through-flow program recently developed in-house. The measurements from the compressor are to be compared with the results of computations over the available speed range to assess the validity of current design/analysis tools. A review of tip clearance effects in compressors was also completed.
Publications:	R. E. Peacock, "Blade Tip Gap Effects in Turbomachines--A Review," NPS Technical Report, NPS67-81-016, November 1981.

F. Neuhoff, "Calibration and Application of a Combination Temperature-Pneumatic Probe for Velocity and Rotor Loss Distribution Measurements in a Compressor," NPS Contractor Report, NPS67-81,03CR, December 1981.

H.-J. Heinemann, "Dual-Probe Digital Sampling (DPDS) Technique for Rotor Flows--Review of the Development and an Assessment Based on Early Results," NPS Technical Report, NPS67-82-009, April 1982. |
| Thesis Directed: | J. A. Ferguson, "Finite Element Program for Calculating Flows in Turbomachines with Results for NASA Task-1 Compressor," _Aeronautical Engineer's Thesis_. October 1982. |

Title: Very High Reaction Turbines

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion
                          Laboratory, Department of Aeronautics

Sponsor: NPS Foundation Research Program

Objective: To investigate analytically and experimentally the
                          potential of two proposed very high reaction
                          turbines of original design.

Summary: A turbine concept involving a simple, easily machined
                          rotor geometry has been promoted by Mr. Carlos
                          Fernandez. An analysis was completed of the potential
                          of the prototype geometry and was programmed to allow
                          variation of the available parameters. Plans to test
                          the prototype were not yet realized. The concept may
                          be useful in drive applications from compressed gas
                          energy storage systems. An apparatus to measure
                          static torque of a detonative combustion turbine
                          concept was built and will be tested in coming
                          months.

Thesis Directed: J. R. Martin, "Evaluation of a High Reaction Super-
                          sonic Turbine Concept," Master's Thesis, June 1982.

Patent   S. Eidelman, "Rotary Detonation Engine," applied
Application: March 13, 1982, Navy Case Number 65681.

DEPARTMENT

OF

OCEANOGRAPHY

DEPARTMENT OF OCEANOGRAPHY

The research program of the Department of Oceanography may be considered under five headings according to the facilities utilized and topics considered. These headings are: R/V ACANIA program; coastal ocean studies; shore processes studies; artic studies; open ocean studies; and environmental acoustic studies.

R/V ACANIA PROGRAMS

In this category are efforts to upgrade the research capabilities of the Naval Postgraduate School's R/V ACANIA, an oceanographic research vessel supported by the Commander, Naval Oceanography Command. (Some investigators also make use of other research ships.)

E. B. Thornton and T. P. Stanton have been implementing an acoustic doppler speed profiling system in R/V ACANIA. The sponsor is the NPS Foundation Research Program.

COASTAL OCEAN STUDIES

J. B. Wickman pursued the data processing of an observational of the California Countercurrent. The field study had included (1) a year's continuous mointoring of the core of the Countercurrent with an array of moored current meters, and (2) a broader monthly sensing of the region with densely-spaced, mass-field profiling. The study region is one of relatively uncluttered sea floor topography on the continental slope off Big Sur. The sponsors of the earlier phases were the NPS Research Foundation and NASA. The BLM/OCS program has sponsored the analysis phase, which has involved C. N. K. Mooers, too.

E. C. Haderlie uses ACANIA to study the biology of stone and wood boring organisms in the deeper waters of Monterey Bay. His purpose is to determine the identity and the vertical and horizontal distribution of these borers as well as their growth rates, settlement times, and destructive effects. The sponsor is the Office of Naval Research.

E. D. Traganza uses the ACANIA off the coast of California in a study of the chemical mesoscale associated with ocean fronts in the coastal upwelling region off Pt. Sur. Cruises are coordinated with satellite imagery obtained from the National Environmental Satellite Service at Redwood City. This study attempts to link physical, chemical, and biological properties in this and similar regions. The sponsor is the Office of Naval Research.

SHORE PROCESSES STUDIES

E. B. Thornton is studying the kinematics and energetics of breaking waves in the surf zone. His research is based on measurements of water particle motion within the surf zone. The sponsor is the Office of Naval Research.

E. B. Thornton and S. Aranuvachapun are developing criteria for breaking waves based on field measurements. The National Science Foundation is the sponsor.

ARCTIC STUDIES

D. C. Smith, IV, R. G. Paquette, and R. H. Bourke are studying the circulation of the Chukchi Sea with a numerical model. The sponsor is the NPS Foundation Research Program.

R. G. Paquette and R. H. Bourke have used U. S. Coast Guard icebreakers to observe and analyze ocean fronts and thermal fine-structure near the ice margin in the Bering, Chukchi, and East Greenland Seas. These studies have applications for environmental acoustics and under-ice submarine operations. The sponsor is the Arctic Submarine Laboratory, NOSC.

OPEN OCEAN STUDIES

R. W. Garwood, in conjunction with R. L. Elsberry and R. L. Haney of the Department of Meteorology, is modeling upper ocean thermal structure. Their investigations of the response of the ocean surface turbulent boundary layer to atmospheric forcing have led to the development of models that can be used to compute upper ocean thermal structure changes if the atmospheric conditions are known. The sponsor is the Office of Naval Research. This effort has led to an applied research program in which the models are used to aid in the analysis of the upper ocean thermal structure, especially in those regions of the ocean that lack frequent observations. NORDA is the sponsor.

A. J. Willmott conducts a theoretical study of countercurrents and eddies in the California Current System. The role of the Mendocino Escarpment waveguide for topographic Rossby waves is under examination at present. The sponsor is the Office of Naval Research.

A. J. Willmott is examing the dynamics of freely propagating (submarine) trench waves on a mid-latitude beta-plane. The sponsor is the NPS Foundation Research Program.

J. L. Mueller is investigating the distributions of upper ocean optical properties associated with fronts and eddies in the California Current, and their influence on satellite imagery visualizations of such. The sponsor is the Office of Naval Research.

J. L. Mueller and S. Aranuvachapun are investigating marine aerosol estimation from the Nimbus-7 Coastal Zone Color Scanner (CZCS) in support of electro-optical propagation forecasts for weapons systems. NEPRF is the sponsor.

J. L. Mueller is investigating the effects of horizontal variability in ocean properties on the validity of optical propagation predictions based on one-dimensional models of the upper ocean. This is part of a Selected Research Opportunity (SRO) program sponsored by ONR in support of the proposed Strategic Laser Communications (SLC) system.

T. R. Osborn and R. G. Lueck are designing, building, testing, and using horizontal and vertical sampling sytems for ocean turbulence. They make measurements from ships and submarines, and in the North Atlantic, North Pacific, and Equatorial Pacific. The sponsors are the Office of Naval Research, NORDA, NPS Foundation Research Program, and National Science Foundation.

C.N.K. Mooers, M. M. Rienecker, and J. A. Smith are conducting an ocean prediction study using the Harvard statistical-dynamical model for open domains. The study is presently focused on eddies, fronts, and jets in the California Current System. Three synoptic realizations of the upper ocean have been acquired with hydrographic sampling from the R/V ACANIA for the purpose of numerical simulation studies. An ancillary study of atmospheric forcing in the Northeast Pacific is in progress; it compares spectrally the FNOC surface analyses with direct observations from NDBO buoys. The sponsor is the Office of Naval Research.

S. P. Tucker is investigating the distribution of the spectral irradiance of natural light and the optical beam spread function of the ocean. The sponsor is DARPA.

ENVIRONMENTAL ACOUSTICS

G. H. Jung, R. H. Bourke, C. R. Dunlap, and R. W. Garwood study relations between atmospheric and oceanic variations and long-range, low-frequency sound propagation and ambient noise in the North Pacific Ocean. Satellite IR imagery is used to infer and interpret oceanic and acoustic variability. The sponsor is NOSC (for COSP and NAVELEX).

C. R. Dunlap, G. H. Jung, and R. H. Bourke are developing ambient noise data bases for the North Pacific and the Norwegian Sea in order to characterize ambient noise received at hydrophone arrays. The sponsor is NAVELEX (PME-124).

Title: Ambient Noise Array Characterization: Data Base
                       Development

Investigators: C. R. Dunlap, Assistant Professor of Oceanography
                       (Principal Investigator), R. H. Bourke, Associate
                       Professor of Oceanography, and G. H. Jung, Professor
                       of Oceanography

Sponsor: Naval Electronics Systems Command

Objective: Exploit ambient noise data bases which include
                       1) two months of aircraft sonobuoy and bottom-
                       mounted hydrophone observations collected as a
                       part of the Acoustic Storm Transfer and Response
                       Experiment (ASTREX) in the northeastern Pacific
                       Ocean in 1980; 2) three years of daily bottom
                       hydrophone observations in the Norwegian Sea, to
                       characterize how environmental phenomena determine
                       the nature of ambient noise signals received at
                       hydrophone arrays.

Summary: During FY82, additional data bases were added and
                       partially analyzed from 1) near Hawaii (seasonal
                       and other temporal trends studied); and 2) near
                       the Aleutian Islands.

Publication: R. H. Bourke, T. H. Holt, and C. R. Dunlap, "Ambi-
                       ent Noise Levels in the Northeast Pacific Ocean as
                       Measured by Aircraft Dropped Sonobuoys," Proceedings
                       of the SACLANT Ambient Noise Workshop, La Spezia,
                       Italy, May 1982.

Title: Upper Ocean Acoustic Effects

Investigators: Calvin R. Dunlap, Assistant Professor of Ocean-
                  ography (Principal Investigator), Roland W.
                  Garwood, Jr., Associate Professor of Oceanography,
                  and Glenn H. Jung, Professor of Oceanography

Sponsor: Naval Ocean Systems Center

Objective: Analyses are made of experimental data taken
                  during research exercises in the northeastern
                  Pacific Ocean to establish the effects of envir-
                  onmental variables such as storms on long range,
                  low frequency acoustic transmission there. Com-
                  parisons are made also between the remotely-sensed
                  sea surface temperature field and concurrent
                  observed subsurface temperature structure.

Summary: Modeled ambient noise levels were compared with in
                  situ ambient noise measurements obtained during
                  six ASTREX (Acoustic Storm Transfer & Response
                  Experiment) flights in November-December 1980 along
                  a line northwestward from Cape Mendocino, CA. The
                  model results differed at higher frequencies during
                  atmospheric frontal activity; ambient noise levels
                  from distant sources may be affected by ocean eddies
                  transited by the noise enroute to receivers. Com-
                  parisons between ambient noise measurements from
                  sonobuoys and bottomed hydrophones during ASTREX
                  were inconclusive from very limited spectral shape
                  and temporal trend studies; further and more de-
                  tailed studies of these data are warranted. The
                  transmission loss predicted by a PE model (entered
                  on the NPS IBM 3033 computer) was compared with the
                  relative signals received at a bottomed hydrophone
                  from SUS charges detonated at different depths
                  along the ASTREX flight lines. PE model limita-
                  tions were evaluated and procedures were recom-
                  mended for further studies of these data and for
                  future experiment design. Correlation between sea
                  surface temperature patterns, the mixed layer
                  depth, and thermocline gradient was best in a
                  region of a warm ocean eddy; empirical formulas
                  were developed for such relations along the ASTREX
                  flight paths.

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Publications: C. R. Dunlap, "Shallow Sound Channels in ASW,"
ICAPS On-Scene, Environmental Systems Division
Newsletter, 4 (1) Naval Oceanographic Office,
January 1982, p. 1-2.

G. W. Lundell, G. H. Jung, and C. R. Dunlap, "Rapid
Oceanographic Data Gathering: Some Problems in
Using Remote Sensing to Determine the Horizontal and
Vertical Thermal Distributions in the Northeast
Pacific Ocean"(Abstract), EOS, Transactions of the
American Geophysical Union, 63 (18), 4 May 1982,
p. 354-355.

Thesis Directed: Stephen A. Cox, "Satellite Applications to Acoustic
Prediction Systems," NPS Technical Report, NPS68-82-005,
Master's Thesis, October 1982.

Title: Studies of the Oceanic Planetary Boundary Layer

Investigator: Roland William Garwood, Jr., Associate Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To understand by means of numerical model studies in conjunction with data analyses the role of the oceanic planetary boundary layer (OPBL) in the distribution of energy, mass and momentum in the upper ocean.

Summary: Progress has been made in a number of areas: (i) A preliminary theoretical assessment has been made of the importance of planetary rotation on the redistribution of turbulent kinetic energy among directional components. This previously neglected process is believed to cause anomalous deepening/shallowing of the OPBL; (ii) Vertical mixing in the Bering Sea of biochemical tracers has been observed and simulated numerically in a prototype experiment. Future experiments of this type may provide valuable insight into the dynamics of turbulent mixing in the upper ocean; (iii) An initial attempt to incorporate satellite observations in modeling of the OPBL proved successful; (iv) Single-station forecasts of 1-D upper ocean thermal structure have been shown feasible on a desk-top computer. This should improve the ability of tactical environmental specialists to make real-time analyses and short-term forecasts for limited geographical areas; (v) An atmospheric planetary boundary layer model (APBL) has been coupled to the OPBL model in a collaborative effort with Professor Ken Davidson (Department of Meteorology).

Publications: R. W. Garwood, Jr., R. W. Fett, K. M. Rabe and H. W. Brandli, "Oceanic Frontal Formation Due to Shallow Water Cooling Effects as Observed by Satellite and Simulated by a Numerical Model," Journal of Geophysical Resources, 86 (C11), 11000-11012, 1981.

R. W. Garwood, Jr., and L. K. Coachman, 1982, "Entrainment of Nutrients and Tracers in the Surface Boundary Layer of the Bering Sea," Submitted to Journal of Physical Oceanography, 1982.

R. W. Garwood, Jr., "Use of a Desktop Computer for Local Upper Ocean Thermal Structure Forecasts,"

in *Ocean Prediction--The Scientific Basis and the Navy's Needs*, Ed. by C. N. K. Mooers, S. Piacsek and A. Robinson, 1982.

D. Adamec, R. L. Elsberry, R. W. Garwood, Jr., and R. L. Haney, "An Embedded Mixed Layer--Ocean Circulation Model," *Dynamic Atmospheric Oceans*, 6, 69-96, 1981.

Conference Presentations: P. C. Gallacher and R. W. Garwood, Jr., "The Effects of Turbulent Mixing on SST Anomalies in the Central North Pacific," Fall Annual Meeting of the American Geophysical Union, San Francisco, December 1981.

P. C. Gallacher and R. W. Garwood, Jr., "A Study of Rotation Stress in the Turbulent Oceanic Planetary Boundary Layer," Fourth Conference on Ocean-Atmosphere Interaction of the American Meteorological Society, 1982.

Theses Directed: W. A. Butler, "A Study of Sea Surface Temperature Variability," *Master's Thesis*, December 1981.

J. R. Burger, "Oceanic Mixed Layer Response to Tidal Period Internal Wave Motion," *Master's Thesis*, June 1982.

Title:	Biology of Stone and Wood Boring Animals in the Monterey Submarine Canyon and the Deeper Waters off the Central California Coast
Investigator:	E. C. Haderlie, Professor of Oceanography
Sponsor:	Office of Naval Research
Objectives:	To determine the vertical and horizontal distribution of stone and wood boring marine animals of the deeper waters of Monterey Bay and offshore, and to determine the rates of destruction of wood, stone, concrete and various plastics. To determine, if possible, the mechanisms used by bivalve molluscs in boring into hard stone.
Summary:	During this past year arrays have been planted and retrieved from deeper water in the canyon. Wood borers are found in the deepest water sampled, yet living stone borers are limited to shallower water. Rates of growth have been monitored using radiography.
Publications:	E. C. Haderlie, "Growth Rates of _Penitella Penita_ (Conrad, 1837), _C. haceia ovoidea_ (Gould, 1851) (Bivalvia: Pholadidae) and Other Rock Boring Marine Bivalves in Monterey Bay," _The Veliger_, 24, October 1981, 109-114.
	E. C. Haderlie, Fifth International Biodeterioration Symposium, Aberdeen, Scotland. Office of Naval Research, London, Conference Report C013-81 (December 1981).

Title: Development of an Expendable Dissipation Profiler

Investigators: Rolf G. Lueck, Adjunct Research Professor of
                        Oceanography, and Thomas R. Osborn, Professor of
                        Oceanography

Sponsor: Naval Oceanographic Research and Development Activity
                        (NORDA)

Objective: To develop a simple, inexpensive, and easy to use
                        expendable instrument for obtaining profiles of the
                        rate of turbulent dissipation of kinetic energy
                        and temperature. To develop the necessary hardware
                        and software for data acquisition and analysis at
                        sea.

Summary: An instrument that meets the above objective has
                        been constructed and partially sea tested. It
                        consists of a shear probe to sense turbulent hori-
                        zontal velocities, a sippican thermistor, and the
                        manufacturer's zinc nose piece and tubing used on
                        T-4 type XBT. In addition, it contains custom-
                        made expendable wire spools for data telemetry and
                        analog signal conditioning electronics. Initial
                        tests at sea indicate that the noise level of this
                        instrument is only 3 to 10 larger than non-expenda-
                        ble instruments. Direct at sea comparisons against
                        non-expendable instruments are in progress. The
                        deck hardware and software for data acquisition,
                        storage and analysis have been constructed and
                        tested.

Publications: Rolf G. Lueck, and Thomas R. Osborn, "The Develop-
                        ment of an Expendable Velocity Microstructure Pro-
                        filer," Surface Ocean Experimental Technology
                        Workshop Proceedings, NORDA, February 1980,
                        pp. 175-184.

                        Rolf. G. Lueck, and Thomas R. Osborn, "Expendable
                        Dissipation Profiler," IEEE, Oceans, September 1981,
                        pp. 377-381.

Title: Dissipation of Kinetic Energy over the Slope off
                      Vancouver Island

Investigators: Rolf G. Lueck, Adjunct Research Professor of
                      Oceanography, William Crawford, Oceanographer,
                      Tides and Currents, Institute of Ocean Sciences,
                      Patricia Bay, British Columbia, Canada, and
                      Thomas R. Osborn, Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To investigate the dissipation and intensity of
                      turbulence over the continental slope and its
                      relation to large scale--low frequency currents.

Summary: Thirteen profiles of the rate of dissipation of
                      turbulent kinetic energy were made over the con-
                      tinental slope off Vancouver Island near the sites
                      of current meters and tide gauges operated for the
                      Coastal Ocean Dynamics Experiment (CODE). The
                      general site if characterized by low levels of
                      mean kinetic energy and shears. An examination of
                      the current meter data demonstrates an absence or
                      low level of eddies, tidal energy, mean currents,
                      coastal waves, and large vertical scale shears.
                      Below 300 meters, mean dissipation rates are the
                      lowest ever observed and are dominated by sporadic
                      events with vertical scales of less than 3 meters.
                      The only identifiable energy source for the obser-
                      ved dissipation rates is the random super-position
                      of internal waves. The observed internal wave
                      energy spectrum agrees well with the 1975 model of
                      Garrett and Munk and must have an e-folding time
                      of approximately 40 days according to the dissi-
                      pation rate observations.

Publication: Rolf G. Lueck, W. C. Crawford, and Thomas R.
                      Osborn, "The Dissipation of Kinetic Energy over
                      the Continental Slope," Submitted to the Journal
                      of Physical Oceanography, 1980.

Title: Kinetic Energy Dissipation in Warm Core Rings

Investigators: Rolf G. Lueck, Adjunct Research Professor of
                    Oceanography, and Thomas R. Osborn, Professor
                    of Oceanography

Sponsor: National Science Foundation

Objective: To measure the three-dimensional distribution and
                    intensity of turbulence, as indicated by the
                    turbulent dissipation of kinetic energy, in warm
                    core rings shed by the Gulf Stream.

Summary: Three surveys of a warm core ring have been made
                    as a part of a large inter-disciplinary effort.
                    Dissipation observations have been made from the
                    surface to depths of up to 2000 meters. These
                    indicate that rings are highly dissipative com-
                    pared to their ambient environment. Dissipation
                    and hence friction is concentrated in the 5 to
                    15° C isotherms and regions of cold fresh intru-
                    sions on the perimeter of the ring. The interior
                    core of water of Sargasso Sea origin has extremely
                    low levels of turbulence. Field data is being
                    analyzed to further illustrate the geographic dis-
                    tribution of turbulence, its dependence on shear
                    and stratification and its implications for the
                    mean energetics of Gulf Stream rings.

Conference
Presentations: R. G. Lueck, "Recovery of Turbulence Profiler Camel
                    II during Rough Weather on Board the R/V ENDEAVOR,
                    in Gulf Stream Ring 81-D," Seminar given at the Insti-
                    tute of Ocean Sciences, Patricia Bay, Canada,
                    September 1981.

                    R. G. Lueck, "Detail of Turbulence Profiler Camel II
                    Showing 2 Shear Probes and Thermistor on Bottom and
                    Lead Ballast and Release Mechanism on Top," Seminar
                    given at the Institute of Ocean Sciences, Patricia
                    Bay, Canada, September 1981

RECOVERY OF TURBULENCE PROFILER CAMEL II DURING ROUGH WEATHER ON
BOARD THE R/V ENDEAVOR, IN GULF STREAM RING 81-D, SEPTEMBER 1981.

DETAIL OF TURBULENCE PROFILER CAMEL II SHOWING 2 SHEAR PROBES AND THERMISTOR ON BOTTOM AND LEAD BALLAST AND RELEASE MECHANISM ON TOP.

Title: Turbulent Dissipation around the North Pacific
                    Subtropical Front

Investigators: Rolf G. Lueck, Adjunct Research of Oceanography
                    and Thomas R. Osborn, Professor of Oceanography

Sponsor: Office of Naval Research
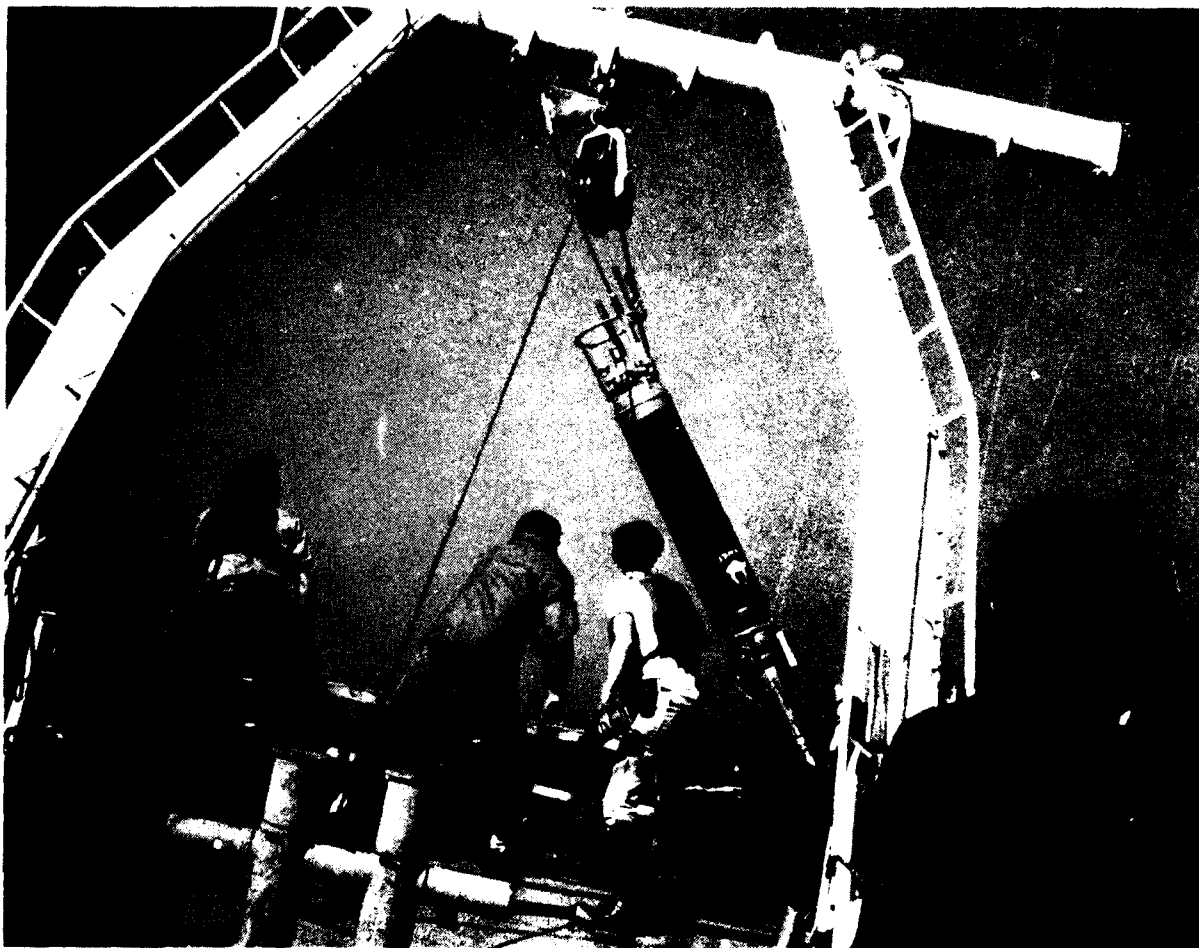
Objective: To measure the three-dimensional distribution and
                    intensity of turbulence as indicated by the rate
                    of dissipation of kinetic energy, around the
                    North Pacific Subtropical Front near 30°N and
                    154°W.

Summary: An intense survey of dissipation rates from the
                    surface to 1100 meters depth was made around the
                    subtropical front as a part of a multi-institu-
                    tional study. The observations show the large
                    horizontal gradients of heat, salt and density
                    are converted into even larger but vertical gradi-
                    ents by the intrusion of denser surface water from
                    the north side of the front under water on the
                    south side of the front. The vertical depth of
                    these intrusions appear to correspond to a maximum
                    in the vertical wave-number spectrum of inertial
                    oscillations implicating inertial waves as a
                    mechanism for cross-frontal fluxes. The vertical
                    turbulent diffusion of mass is being estimated
                    from the dissipation rate observations to be com-
                    pared (on an order of magnitude basis) against
                    the cross-frontal fluxes.

Publication: Rolf G. Lueck, "Dissipation in the North Pacific
                    Subtropical Front," Manuscript Report No. 38,
                    Department of Oceanography, University of British
                    Columbia.

Title: The Vertical Dissipation Profiler Camel IV

Investigator: Rolf G. Lueck, Adjunct Research Professor of
                    Oceanography

Sponsor: Office of Naval Research

Objective: To improve and further extend the capabilities of
                    vertical turbulence profiling instruments known
                    as CAMELS. In particular it is desired to have an
                    instrument capable of obtaining CTD quality data
                    in addition to turbulence measurements, that can
                    record internally and telemeter digital data to the
                    surface, and can profile to depths of 5000 meters.
                    Such an instrument would be suitable for obtaining
                    data in all oceanic environments particularly in
                    the Gulf Stream where instrument limitations have
                    in the past prohibited successful measurements.

Summary: The required electronics instrumentation has been
                    developed and tested. It consists of a high speed
                    15 bit analog-to-digital converter, a hardwired
                    controller that facilitates the multiplexing of 16
                    analog and 16 digital data channels and generates
                    a RS-232 digital data stream for telemetry to the
                    surface and/or internal recording on a protable
                    stereo cassette recorder. A deck receiver for
                    real-time monitoring of all data channels through
                    digital-to-analog converters and communication with
                    a DEC LSI-1123 computer in serial or parallel for-
                    mat. With the electronic design finalized the
                    mechanical design of the pressure vessel, nose
                    piece, ballast releases, launch and recovery
                    mechanism is now in progress. A by-product of the
                    development work to date is that the electronics
                    are general enough to be used in a wide variety of
                    data acquisition modes. In particular it will be
                    transferred to T. Osborn for his work on horizontal
                    profiling measurements.

Title: Eddies in the California Current System

Investigators: C. N. K. Mooers, Professor and Chairman of
                    Oceanography, J. A. Smith, Research Adjunct
                    Professor of Oceanography, and M. M. Rienecker,
                    Research Adjunct Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To characterize synoptic scale eddies offshore of
                    California.

Summary: Several oceanographic cruises have been undertaken
                    to gather temperature and conductivity (salinity)
                    data, with much finer station spacing then his-
                    torical data in the region. Software for objec-
                    tive analysis and dynamic modelling are being
                    developed for routine application in near-real
                    time, both underway (as the data is gathered) and
                    ashore (on the Naval Postgraduate School's IBM
                    3033 mainframe computer). The highly energetic,
                    hitherto neglected mesoscale activity will be des-
                    cribed, both statistically and by realization, and
                    also the relationship with the larger-scale mean
                    flow and topography should be brought to light.

Title:	Applications of CACS to Electro-Optical Propagation Analysis and Prediction in the Marine Boundary Layer
Investigators:	James L. Mueller, Adjunct Professor of Oceanography and Sasithorn Aranuvachapun, Adjunct Professor of Oceanography
Sponsor:	Naval Air Systems Command/Naval Environmental Prediction Research Facility
Objective:	To develop and implement algorithms for using CZCS data to map aerosol distribution variations in support of electro-optical propagation forecasts for weapons systems.

Summary:	An inherent byproduct of the CZCS atmospheric correction process is an image of "aerosol radiance" at a wavelength of 670 nm. "Aerosol radiance" is the fraction of radiance measured from space due to backscatter of solar radiation by atmospheric aerosols. Over space scales less than the meteorological synoptic scale, it is hypothesized that variations in aerosol radiance relate directly to variations in the concentration and/or size distribution of aerosols in the marine planetary boundary layer. Preliminary results from the project have shown that this interpretation can be confounded by the presence of either a thin cloud layer, or small unresolved clouds. In even such circumstances, however, the variability observed in CZCS aerosol radiance may prove to be a useful input for electro-optical forecasts of slant path range for sensors above the boundary layer. In the more restricted circumstance that the structure is confined to the planetary boundary layer, the information may aid forecasts of horizontal paths as well.

Title: Horizontal Variability Effects on Optical
                          Propagation in the Upper Ocean

Investigator: James L. Mueller, Adjunct Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To account for and test the effects of horizontal
                          variability and advection in a model forecasting
                          optical propagation in the upper ocean.

Summary: As part of the Office of Naval Research sponsored
                          SRO project entitled, "Environmental Effects on
                          Optical Propagation," the present project contrib-
                          utes a study of the effects of horizontal varia-
                          bility on predictions of downward vector irradiance
                          propagation. A major goal of the parent program
                          is the development and testing of an irradiance
                          propagation forecast model for the upper ocean
                          in support of the Navy's performance evaluation of
                          the proposed Strategic Laser Communications (SLC)
                          system. Efforts in 1982 emphasized acquisition and
                          processing of CZCS data, and preparations for a
                          major field experiment, the Optical Dynamics Ex-
                          periment, to take place in the central NE Pacific
                          ocean aboard the R/V ACANIA for 6 weeks in October-
                          November 1982.

Title: Satellite Visualizations of Fronts and Eddies in
                the California Current

Investigator: James L. Mueller, Adjunct Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To understand how distributions of upper ocean opti-
                cal properties, which produce visualizations of
                fronts and eddies in satellite images, are governed
                by ocean circulation and mixing processes in the
                California Current.

Summary: An ensemble of Coastal Zone Color Scanner (CZCS)
                images from the period May through November 1982
                was acquired and is being processed into the form
                of derived maps of phytoplankton pigment
                (chlorophyll-a plus phaeopigments-a) concentrations
                and vector irradiance attenuation coefficients
                for the shelf-slope region between Pt. Arguello
                and Pt. Sur on the California Coast. Two cruises
                aboard the R/V ACANIA were used to gather pre-
                liminary optical, biological and physical oceano-
                graphic data to be used eventually for computing
                cross-correlations between sub-surface parameters
                and surface structure observed in satellite images.

Title: Evaluation of Towed Body Turbulence Measurements

Investigator: T. R. Osborn, Professor of Oceanography

Sponsor: NPS Foundation Research Program

Objective: The objective is to determine the feasibility of
                  using a towed body for oceanic turbulence measure-
                  ments. Previous open ocean turbulence measurements
                  have been made with a free fall vehicle or from
                  submarines. Our hope is to make horizontal
                  transects with a towed body. Thus we would have
                  data that previously only came from a submarine
                  platform with the simplicity of operation typical
                  of a free fall body.

Summary: A towed body was borrowed from Applied Physics
                  Laboratory/Johns Hopkins University. It was modi-
                  fied slightly for our operation. We locked the
                  control surfaces, smoothed the body by removing
                  various attachments, and increased the roll sta-
                  bility by adding a keel. Our plan was to tow the
                  body not as a depressor, but rather with an almost
                  horizontal cable well behind the surface ship.
                  This approach minimizes the tension in the cable.
                  Field tests were very positive. The work is being
                  continued in 1983 with NORDA Ocean Measurements
                  Program funding.

Title: An Intercomparison of Horizontal and Vertical
                    Turbulent Profiling

Investigators: Thomas R. Osborn, Professor of Oceanography, Rolf
                    G. Lueck, Adjunct Research Professor of Ocean-
                    ography, and Ann Gargett, Institute of Ocean
                    Sciences, Patricia Bay, British Columbia, Canada

Sponsor: Office of Naval Research

Objective: To compare and contrast observations of the rate
                    of dissipation of turbulent kinetic energy made
                    by horizontal profiling using the USS DOLPHIN
                    submarine and vertical profiling using the free
                    fall vehicle CAMEL 11. To measure the horizontal
                    coherence of turbulence features observed by ver-
                    tical profiles and estimate the statistical
                    reliability of vertical profiles.

Summary: Simultaneous observations of turbulence were made
                    for 21 days in April 1982, about 20 miles off the
                    California coast near San Diego. The USS DOLPHIN
                    submarine was used to obtain horizontal profiles
                    around the vertical profiles made by CAMEL 11 from
                    the R/V ACANIA. The CAMEL was operated in a yo-yo
                    mode; it was attached to the surface ship by a
                    light-weight high-strength electro-mechanical
                    kevlar cable. This facilitated frequent profiling
                    (over 200) and real-time communication. Data
                    analysis is in progress.

Title: Turbulence Measurements from U.S.S. DOLPHIN

Investigator: T. R. Osborn, Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To perform turbulence measurements from the U.S.S.
                  Dolphin in conjunction with turbulence profiles
                  from the R/V ACANIA. This work is designed to
                  increase our knowledge of the role of turbulent
                  processes in the ocean.

Summary: One month of joint operations with the DOLPHIN
                  and ACANIA occurred in April 1982. Survey patterns
                  from ACANIA using XBT's and a CTD were used to map
                  the operational area off San Diego. Sixteen dives
                  were made with the DOLPHIN and turbulence data
                  corresponding to a linear distance of 200 miles was
                  collected. When combined with the vertical pro-
                  files from ACANIA, we have a unique data set as
                  well as the largest data set of ocean turbulence
                  measurements. Analysis of the data is going well.
                  The plan is to reduce the total data set while
                  preparing initial publications on the system, salt
                  fingers in the upper layer, and a selected series
                  of frontal crossings.

Conference
Presentation: T. R. Osborn, R. G. Lueck, and A. E. Gargett,
                  "Turbulence Measurements from a Submarine,"
                  Joint Oceanographic Assembly, Halifax, Canada,
                  August 1-14, 1982.

Title:	Marginal Sea-Ice Zone Studies, 1982
Investigators:	Robert G. Paquette, Professor of Oceanography, and Robert H. Bourke, Associate Professor of Oceanography
Sponsor:	Naval Ocean Systems Center, Arctic Submarine Laboratory
Objectives:	To carry out physical oceanographic research, including field measurements, in the Marginal Sea-Ice Zone of the Bering, Chukchi and Greenland Seas. This work has the long-term applied objective of facilitating the operation of submarines under ice. It is part of the continuing MIZPAC and MIZLANT programs.
Summary:	The past decade of our marginal ice zone studies have been associated with the Pacific Ocean (Bering, Chukchi, and Beaufort Seas). During October-November 1981 we conducted our first cruise to the East Greenland Ice Stream of the Atlantic Ocean. Data editing and analysis are nearly completed. A paper summarizing the spatial and temporal characteristics of the East Greenland Polar Front is in preparation. Because of the paucity of data from this region, these results are being used by various researchers in planning for the MIZEX experiment, an intensive, multidisciplinary field program to be conducted along the East Greenland Ice Stream in July 1984. The results of the 1980 winter cruise to the Bering Sea is in the final stages of preparation.
Conference Presentations:	Robert G. Paquette, Robert H. Bourke, John L. Newton, and William F. Perdue, "Oceanographic Conditions at the On-Set of Winter in the Marginal Ice Zone of the Greenland Sea." American Geophysical Union Fall Annual Meeting, San Francisco, 7-11 December 1981.
	Robert H. Bourke, "Early Winter Observations of the Polar Front." Arctic Modeling Meeting, University of Cambridge, England, 21-25 June 1982.
Thesis Directed:	William F. Perdue, "Oceanographic Investigation of the East Greenland Polar Front in Autumn," Master's Thesis, March 1982.

Title: Numerical Ocean Circulation Study of the Chukchi
                    Sea

Investigators: D. C. Smith, IV, Adjunct Professor of Oceanography,
                    R. W. Paquette, Professor of Oceanography, and
                    R. Bourke, Associate Professor of Oceanography

Sponsor: NPS Foundation Research Program

Objectives: Summer melting of the ice cover in the Chukchi Sea
                    suggests the oceanic flow is largely dominated by
                    topographic features. An investigation utilizing
                    a numerical model with variable flow and topography
                    was undertaken to test this hypothesis.

Summary: A two layer semi-implicit numerical model was adapted
                    for use in a dynamical study of circulation in the
                    Chukchi Sea. Several boundary conditions were
                    tested for modelling of northward outflow. A range
                    of experiments with variable inflow vertical structure
                    was conducted.

Title:	Breaking Wave Design Criterion
Investigators:	E. B. Thornton, Professor of Oceanography, and Sasithorn Aranuvachapun, Adjunct Professor of Oceanography
Sponsor:	National Science Foundation

Objective: This is a new two year program devoted to developing a net set of breaking wave design criteria based on field measurements of random waves. The impetus for this study is due to the deficiencies of the present methods based on monochromatic laboratory waves. The design criteria will be stated in statistical terms based on a probabilistic model.

Summary: A model describing the transformation of random wave heights was developed based on energy flux balance. Dissipation is considered due to wave breaking and bed friction. Wave breaking is characterized after periodic bores. The random nature of the wave heights is described starting with the Rayleigh distribution in deep water. The Rayleigh distribution is modified by wave breaking with an empirical transfer function. The modified distribution is itself the Rayleigh distribution. Field experiments were conducted at Soldiers Beach, Fort Ord, California, during the month of May and again for three weeks in August. The experiments were conducted in cooperation with the U. S. Geological Survey and Oregon State University.

Publication: E. B. Thornton, and R. T. Guza, "Transformation of Wave Height Distribution," Submitted to the Journal of Geophysical Research.

Title:	Implementation of Acoustic Doppler System Profiler
Investigators:	E. B. Thornton, Professor of Oceanography, and T. P. Stanton, Adjunct Professor of Oceanography
Sponsor:	NPS Foundation Research Program
Objective:	The objectives of this research are to develop the Amatek Straza ADSP, integrate it with ocean measurements from the ACANIA Data Acquisition System (DAS) and investigate the response of the upper ocean currents to the wind stress at the surface.

Summary:	Software was written on an HP 9826 to acquire, process and record the ADSP data stream, and interact with the R/V ACANIA Data Acquisition System computer. Algorithms to unpack the ADSP data, compensate for pitch and roll and resolve absolute velocity components are written for post-processing on the NPS mainframe. Methods have been developed to display these data together with DAS logged surface information and CTD/XBT profiles. A successful three day cruise was conducted to use the acoustic doppler profiler system (ADSP) to measure wind induced shear currents in the upper hundred meters of the ocean. Absolute velocity measurements were acquired using mini-ranger navigation. Wind stress is inferred from wind velocity measurements. Maximum windspeeds exceeded 20 m/s during the experiment. The density field was monitored by a two-yowed CTD. The measurements are compared with a time dependent Ekman upper boundary layer model giving reasonable results.

Publications:	E. B. Thornton and T. P. Stanton, "Absolute Current Measurements using a Ship Mounted Acoustic Doppler Speed Profiler," NPS Technical Report, in progress.
	E. B. Thronton and T. P. Stanton, "Current Velocity Measurements through the Mixed Layer," Journal of Geophysical Research, in progress.

Title: Kinematics of Breaking Waves in the Surf Zone

Investigator: Edward B. Thornton, Professor of Oceanography

Sponsor: Office of Naval Research, Geography Branch

Objective: Basic studies are being made on the kinematics of breaking waves within the surf zone in the field. The specific objectives of the proposed research are: (1) determine breaking criterion as a function of depth, beach slope and wave frequency, and (2) determine the transformation of waves across the surf zone due to energy conversion and dissipation in the breaking process.

Summary: Research this past year emphasized the continued analysis of the results of the major field experiments at Torrey Pines, California and Santa Barbara, California, and the development of predictive models. A model describing the transformation of random wave heights was developed based on energy flux balance. Dissipation is considered due to wave breaking and bed friction. Wave breaking is characterized after periodic bores. The random nature of the wave heights is described starting with the Rayleigh distribution in deep water, but the modified distribution is itself the Rayleigh distribution. The model is compared both with laboratory results and an extensive set of field measurements collected at Torrey Pines Beach, California. The model is able to predict the increase in rms wave height due to shoaling and subsequent decrease due to wave breaking.

Publications: R. T. Guza, and E. B. Thornton, "Wave Set-up on a Natural Beach," _Journal of Geophysical Research_, 86, 4133-4137, 1981.

D. A. Huntley, R. T. Guza, and E. B. Thornton, "Field Observations of Surf Beat: Part 1, Progressive Edge Waves," _Journal of Geophysical Research_, 86, 1981.

E. B. Thornton, and R. T. Guza, "Longshore Currents and Bed Shear Stress," _Proceedings of the Directional Wave Spectra Applications, '81 Conference_, September 1981, pp. 238-256.

E. B. Thornton, and R. T. Guza, "Phase Speeds and
Energy Saturation Measured on a Natural Beach,"
Journal of Geophysical Research, forthcoming.

E. B. Thornton, and R. T. Guza, "Transformation of
Wave Height Distribution," submitted to the
Journal of Geophysical Research.

R. T. Guza, and E. B. Thornton, "Velocity Moments
in the Nearshore," submitted to the Journal of
Coastal Engineering.

R. T. Guza, and E. B. Thornton, "Swash Oscillations
on a Natural Beach," Journal of Geophysical
Research, 87, p. 483-491, 1982.

Title:	Satellite and Synoptic Studies of Chemical Fronts in the California Current and Coastal Upwelling Zone
Investigator:	Eugene D. Traganza, Associate Professor of Oceanography
Sponsor:	Office of Naval Research
Objectives:	This project is part of a continuing research program in satellite and synoptic oceanography and ocean prediction. The objectives are: to describe and develop bio-chemical models of frontal systems in the upper ocean; to couple these models to remote sensing by satellites for the purpose of mapping and forecasting bio-chemical, acoustic and optical properties.

Summary: This year has been a period of transition following the culmination of several years of successful work which produced the discovery of coastal cyclonic upwelling systems and giant plumes off Pt. Sur, California, the first sea surface nutrient maps derived from satellite measurements, the first report of these chemical maps in combination with satellite-derived phytoplankton maps revealing a general relationship between chemical gradients and biomass in the upper ocean. During this year the project was without an assistant. However, Adjunct Professor Dr. D. G. Redalje was recruited at SIO where Dr. Traganza was on sabbatical. A subcontract was let with Dr. John Van Leer, RSMAS to collaborate on the design of a 2nd generation towed ocean water sampling system (TOSS-2). TOSS-1 was used in a 3-D mapping experiment to investigate the extent to which surface information from satellites can be extrapolated over depth. The satellite depth was processed by Dr. Traganza at the Scripps Satellite Oceanography Facility. Continuing interest in the project was evidenced by invitations to speak at the IUGG in Hamburg, AGS in Seattle, NORDA in Bay St. Louis and to join the University of Rhode Island in a trace metal study off Peru in December 1983.

Publications: E. D. Traganza, V. M. Silva, D. M. Austin, W. E. Hanson and S. H. Bronsink, "Nutrient Distribution and Recurrence of Coastal Upwelling Centers by Satellite Remote Sensing: Implications to Primary Production and the Sediment Record," <u>NATO Advanced</u>

Research Conference on Coastal Upwelling: Its Sediment Record, Plenum Press, 1982.

E. D. Traganza, "Design Requirements for a Towed Oceanwater Sampling System (TOSS)," NPS Technical Report, forthcoming.

Conference
Presentations: E. D. Traganza, "Satellite and Synoptic Studies of Chemical Fronts," Invited Talk, Environmental Sciences Division, Naval Research Laboratory, Washington, D. C., October 1981.

E. D. Traganza, "Satellite and Synoptic Studies of Chemical Fronts," Invited Talk, Atlantic Meteorological and Oceanographic Laboratory, Virginia Key, Miami, Florida, December 1981.

E. D. Traganza, "Satellite and Synoptic Studies of Chemical Fronts," Invited Talk, Institute of Marine Resources, UCSD Scripps Institution of Oceanography, La Jolla, California, February 1982.

Thesis Directed: V. M. Silva, "Thermal Calibration of Satellite Infrared Images and Correlation with Sea Surface Nutrient Distribution," Master's Thesis, June 1982.

Title:	Investigation of the Distribution of the Spectral Irradiance of Natural Light and the Optical Beam Spread Function of the Ocean
Investigator:	S. P. Tucker, Assistant Professor of Oceanography
Sponsor:	Defense Advanced Research Projects Agency
Objective:	The primary objective is to relate in terms of the dynamics of the upper ocean certain optical and optical-related properties which are measurable in situ, such as the beam attenuation coefficient, the volume scattering function, spectral irradiance, beam spread function, etc., to simultaneous backscatter measurements made by means of a ship-mounted lidar system.

Summary:	The approach has been--together with a group at SRI, International--to assemble and calibrate suitable instrumentation, testing the various components and instruments at sea in California waters using the R/V ACANIA as a platform. In August and September 1982 a series of from one- to four-day cruises, termed LIDEX-82, was made in the vicinity of Key West, Florida, during which simultaneous lidar, optical oceanographic and physical data were collected, including time series as long as 12 hours. During quarters I and II of FY-83 analysis of beam transmission, particle size distributions and light scattering will be made with particular reference to the simultaneous lidar return signals and thermistor chain and CTD data. A second series of joint experiments will be performed in June 1983. A special effort will be made to identify the particles responsible primarily for the observed optical scattering.

Title:	Countercurrents and Eddies in the California Current System
Investigator:	A. J. Willmott, Assistant Professor of Oceanography
Sponsor:	Office of Naval Research
Objective:	To understand how low frequency topographic Rossby waves contribute to the dynamics of eastern boundary current systems. Large scale bottom topographic features such as the Mendocino Escarpment act as an oceanic wave guide for topographic Rossby waves, and it is hoped to understand how the circulation is influenced by the presence of these waves.
Summary:	A study of the flow past headlands, bays and multiple headlands and bays has been completed and accepted for publication. The dynamics of unforced trench waves in an ocean trench located on a mid-latitude beta-plane has also been completed. A model for the generation of the forced internal double Kelvin waves in a 2-layer ocean over Mendocino escarpment is near completion. An extension of this calculation involving a semi-infinite escarpment is underway with Prof. Latta (Mathematics, NPS) and Dr. M. Rienecker (Oceanography, NPS).
Publications:	A. J. Willmott, "The Influence of a Coastal Headland on Oceanic Boundary Currents," Geophysical and Astrophysical Fluid Dynamics, Forthcoming.

A. J. Willmott, and A. A. Bird, "Freely Propagating Trench Waves on a Beta-plane," Submitted to Journal of Physical Oceanography.

A. J. Willmott, and A. A. Bird, "Freely Propagating Trench Waves on a Beta-plane," Ocean Modelling, Forthcoming. |
| Conference Presentations: | A. J. Willmott, "The Influence of a Coastal Headland on Oceanic Boundary Currents," EPOC Meeting, Idyllwild, CA., October 29-31, 1981.

A. J. Willmott, "The Influence of a Coastal Headland on Oceanic Boundary Currents," Fall AGU Meeting, San Francisco, December 7-11, 1981. |

A. J. Willmott, "Freely Propagating Trench Waves on a Beta-plane," 16th Annual Congress of CMOS, 26-28 May, 1982.

A. J. Willmott, "Freely Propagating Trench Waves on a Beta-plane," JOA, Halifax, Canada, 2-13 August, 1982.

Title:	Trench Wave Dynamics
Investigator:	A. J. Willmott, Assistant Professor of Oceanography
Sponsor:	NPS Foundation Research Program

Objective:
To examine the dynamics of freely propagating trench waves on a mid-latitude beta-plane using analytic techniques. For different Pacific Ocean trenches the period and wavelength for which the waves can no longer be coastally trapped are calculated.

Summary:
Dispersion curves for trapped trench waves are calculated for the Japan, Juril and Peru trenches. The hyperbola $\omega_c = \beta(1 - \sin \nu)/2k_c$ partitions wave number-frequency space. The region bounded by the coordinate axes and the critical curve corresponds to the continuum of leaky trench waves. The leaky waves take the form of linear Rossby waves in the ocean interior. Therefore the generation of trench waves may ultimately lead to another source of barostropic Rossby waves in the Pacific Ocean.

Publications:
A. J. Willmott, and A. A. Bird, "Freely Propagating Trench Waves on a Beta-plane," Submitted to Journal of Physical Oceanography.

A. J. Willmott, and A. A. Bird, "Freely Propagating Trench Waves on a Beta-plane," Ocean Modelling. Forthcoming.

Conference Presentations:
A. J. Willmott, "Freely Propagating Trench Waves on a Beta-plane," 16th Annual Congress of CMOS, 26-28 May, 1982.

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DEPARTMENT

OF

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

The research program in the Department of Mechanical Engineering has continued in several areas: applied mechanics; design and optimization; heat transfer; hydrodynamics and fluid mechanics; and materials science.

APPLIED MECHANICS

Professor Newton has continued his research on application of the finite element method to analysis of the response of submerged structures to underwater shock waves. For each of the past two years, he has spent a month as visiting professor of structural mechanics at Ecole Nationale Supériure de Mécanique, University of Nantes. Activity there has included lectures and research collaboration in this specialty area.

Professor Cantin's activities in computer graphics have continued, both with main frames and smaller computers. The GIFTS system was installed in the VAX780 of the Computer Laboratory. (GIFTS stands for Graphics, Interactive, Finite Element, Time-Sharing System.) The system is now available from the IBM3033, VAX780 and PDP11 for all NPS students and faculty. Efforts have been made by Professor Cantin to interact with the Army Materials and Mechanics Research Center, Watertown, MA. He will instruct them on using GIFTS to perform some stress and strain analysis for various machine parts. A finite element book was translated from the French by Professor Cantin and is due to be published some time in 1983 by John Wiley and Sons.

Professor Shin, a new faculty member, initiated a numerical and experimental program to study the dynamic responses of submerged structures under shock and vibration environments. The thin wall ring-stiffened cylinder with bulkheads is considered and the impulsive shock loading is to be applied at the outside surface of the cylinder. Failure modes and the corresponding structural responses will be studied. Professor Shin and his student continued their investigation of reliability-based analysis of high-cycle fatigue life under the random vibration environment. The objective of this study is to develop an improved prediction method of fatigue damage which takes into account the wide statistical variability of the cumulative fatigue damage index(Δ) at failure. The measure of fatigue reliability is expressed in terms of probability of failure. The computer program has been developed to calculate the fatigue reliability of a component under the random stress responses. Professor Shin initiated a project on damping measurement and modal analysis at low stress level for propeller materials for the David W. Taylor Naval Ship Research and Development Center. Various types of materials will be used to measure the damping at high frequency range and at various temperature ranges.

DESIGN AND OPTIMIZATION

Professor Vanderplaats continued his work for NASA on the development of a library of automated design optimization algorithms. In October, Dr. Hiroyuki Sugimoto of Mororan Institute of Technology, Japan, joined in this effort as a research associate. A preliminary program is near completion

and contains more than fifty different combinations of optimization algorithms. Professor Vanderplaats continued distribution of his optimization program, COPES/CONMIN. An example industrial application of this code was its use in optimal choice of experimental tests by an engine manufacturer, reducing the number of required test points by 75%. Other reported applications include stiffened composite panel optimization and the design of fan blades for an energy efficient engine. Professor Vanderplaats continued his investigations in structural optimization, probabilistic design, and application of optimization techniques to the design of machine components, including shafts and marine reduction gears, as examples.

HEAT TRANSFER

Professor Marto has continued his investigation of heat transfer augmentation techniques which occur in two-phase heat exchange equipment such as boilers and condensers. Together with Professor Nunn, an extensive effort has been made to examine the benefits of using augmented heat transfer in a naval surface condenser. Using a one-dimensional computer code, it has been shown that the use of enhanced tubes can lead to savings in weight and volume of almost 50 percent. The effect of condensate inundation upon heat transfer performance is being examined with a fine tube steam condenser apparatus. Under National Science Foundation sponsorship, Professor Marto has initiated a joint program with Dr. John Rose of Queen Mary College, London. The objective of this program is to experimentally determine enhanced condensation of steam on single horizontal tubes using finned tubes, new drainage techniques and the promotion of dropwise conditions. Professor Marto continued his experimental work with nucleate pool boiling from enhanced surfaces. A detailed study is being made on the performance characteristics of Gewa-T finned tubing.

Professors Salinas and Marto continued their work on the use of the Finite Element Method to predict heat transfer performance in an internally finned rotating heat pipe. A computer program has been developed to show the effects of heat pipe working fluid, wall material, fin geometry and heat pipe operating characteristics upon heat pipe thermal performance. More complete theoretical models are now being formulated.

Professor Pucci initiated a study of heat transfer in a fluidized bed. The heat transfer and fluid flow characteristics of a rectangular fluidized bed were investigated for a bed with two opposite walls heated, the other pair insulated. The heated walls are movable to obtain beds of varying aspect ratio. Average heat transfer coefficients and pressure drops were obtained.

Professor Garg, an Adjunct Professor, developed a simple but highly accurate variable mesh finite-difference technique to study three dimensional parabolic flows, e.g., the hydrodynamic developing flow in a rectangular duct. He continued his work on the NSF sponsored project, "The Effect of Heating and Cooling on Linear and Nonlinear Goertler Instability on Concave Surfaces." Results to date indicate that heating the boundary layer on a concave surface destabilizes short wavelength disturbances

while cooling does the reverse. Professor Garg also started work on the Foundation Research Program on film condensation heat transfer on vertical fluted tubing with Professor Marto. A finite difference program for the determination of film thickness on the vertical fluted tube has been developed. This program solves the boundary layer equations for the film in curvilinear coordinates, including surface tension effects. Work is now in progress on a finite-element solution for the two-dimensional conduction in the tube wall.

HYDRODYNAMICS AND FLUID MECHANICS

Professor Culbreth initiated an experimental investigation of the fluid mechanics of buoyant liquid plumes. The purpose of this investigation is to study the velocity distributions in and around heated jets of water introduced into a flowing ambient using a Laser Doppler Velocimeter. A Laser Doppler Velocimeter has been purchased and interfaced to a computer-based data acquisition system. The work is being vigorously continued.

Professor Kelleher has continued his study of the simplified boundary conditions for flows over flexible surfaces. The objective of the investigation is to determine the utility and range of validity of linearized boundary conditions in numerical investigations of flow over wavy surfaces. For this purpose, a copy of the spectral code for the analysis of the flow over wavy walls, developed by Cambridge Hydrodynamics, Inc., has been obtained. This code has been installed on the CYBER 170/175 computer at Fleet Numerical Oceanographic Center, Monterey. Presently, this code is being modified to incorporate the simplified boundary conditions.

Professor Nunn continued his investigation of the liquid crystal thermography in jet cross-flow interactions. The purpose of the study is to investigate the feasibility of the use of liquid crystals for mapping the surface interaction field that results when a jet injected into a crossing flow. An experimental system was designed and built. Preliminary tests were conducted in which a number of design improvements were suggested. In general, it was shown that liquid crystal thermography can be a unique and useful method for the qualitative analysis of complex flow fields.

Professor Pucci has continued his work on gas turbine exhaust stack eductor systems. A new and novel exhaust stack geometry was tested to visually shield primary nozzles from overhead view. Results have shown that significant reductions in stack length are possible. Professor Pucci has undertaken an investigation of fluidized bed heat exchangers. The objective of this investigation is to design, fabricate and test a fluidized bed heat exchanger employing a rectangular cross-section bed with two opposite wall heaters.

Professor Sarpkaya continued the investigations of hydroelastic oscillations of cylinders and cables in steady and harmonic flow, discrete vortex numerical modeling of separated time-dependent flows, yaw and

current effects on the flow past smooth and rough-walled cylinders, impulsively-started flow about bluff bodies, and the rise and demise of trailing vortices in stratified and unstratified fluids. The purpose of the harmonic flow studies is to develop an understanding of the vortex shedding about rigid and flexible bodies in order to minimize the consequences of hydroelastic oscillations and in order to determine the force-transfer coefficients for design purposes. The objective of the investigation on trailing vortices is to understand the various demise mechanisms to which a vortex is subjected (turbulent diffusion, vortex breakdown, and sinusoidal instability) and to develop means to precipitate the demise of such vortices in both the unstratified and stratified fluid medium. Extensive experiments and numerical analysis have been carried out on all these investigations with the dedicated help and assistance of the students working toward various degrees in Mechanical Engineering.

MATERIALS SCIENCE

Professor Challenger's research on elevated temperature fatigue has continued. During the last year, he spent three months at the Central Electricity Research Laboratory, Leatherhead, England, studying the effect of oxidation of the growth of "short" fatigue cracks. He has added a computerized data acquisition system and a new system controller that allows automatic mode switching (e.g., load to strain during a test) to the elevated temperature fatigue testing facility. Many hours were spent on the procurement of a new transmission electron microscope. The JEOL 120CX MKII is now installed and operating. His reseach on weldment development for naval applications is now studying (a) the effect of preheating on the properties of HY-80; (b) the possibility of replacing HY-80 with a much lower cost HSLA steel; and (c) the effect of many different welding parameters on the properties of submerged arc weldments in HY-80 and HY-100 with the primary objective of increasing deposition rates. The effects of sample preparation method and processing on the properties of 5 inch steel cartridge cases is under study in conjunction with the Naval Weapons Support Station, Crane, Indiana. A postdoctoral research associate will be joining his research group in the spring of 1983 to assist in the direction of this work.

Professor Perkins continued work on a National Science Foundation sponsored project on martensitic transformation in shape-memory alloys. The main thrust of this research is to determine the effect of microstructural variables on the kinetics and morphology of the martensitic transformations.

Professor McNelley has received funding from the Naval Air Propulsion Center to conduct research on thermomechanical processing of M-50 steel, used in gas turbine bearing and related applications. The processing methods employed were developed in previous work on AISI 52100, another bearing steel, and are intended to refine both

carbide and grain size in the steel. Such microstructural refinement generally enhances the response of such a material during heat treatment and also improves the rolling contact fatigue life in service. A unique feature of this program is that the processing is applied to conventional ingots of the material rather than employing more expensive powder metallurgy methods. Also, under Professor McNelley's guidance is a second, ongoing program on processing of Aluminum-Magnesium alloys. This program is presently supported by the Naval Air Systems Command and seeks to develop fine and stable microstructures in alloys containing up to ten percent Magnesium. Processing is by warm rolling and microstructures generally consist of dislocation cells pinned by precipitated intermetallic particles. Mechanical properties are generally comparable to those of conventional high strength Aluminum alloys with potential for improved corrosion and stress-corrosion resistance.

Adjunct Research Professor Boone continued his work on hot corrosion of gas turbine blade materials. The influence of surface coatings and various metallic additions, such as platinum, upon hot corrosion performance has been experimentally studied.

Title: Contact Problems in Stress Analysis

Investigator: Gilles Cantin, Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: Formulate solution methods for a class of fictitious
                    material elements for contact problems with or without
                    friction.

Summary: All conditions have been established to satisfy stress
                    boundary conditions for contact problems. Numerical
                    results are very good, the formulation of a new class of
                    a fictitous contact element has also been completed.

                    Implementation of this theory in a computer code was
                    contemplated using the GIFTS System. As a part of
                    this project, the GIFTS code was installed in the VAX
                    system of the Computer Science Department. A low
                    cost terminal was purchased for this phase of the
                    work and the terminal retrofitted for Graphics
                    representation. The work continues in fiscal year 1983

Title: The Effect of Prestrain on the Fracture Toughness of
                    HY-Series Steels

Investigator: Kenneth D. Challenger, Associate Professor of Mechanical
                    Engineering

Sponsor: Naval Sea Systems Commmand/David W. Taylor Naval Ship
                    Research and Development Center

Objective: To determine why the fracture toughness, as measured by
                    J integral methods decreases when steel samples are
                    prestrained prior to testing.

Summary: When thick plates are rolled into the shape of a
                    submarine hull a small amount of plastic deformation is
                    required. This plastic deformation has been found to
                    significantly reduce the materials resistance to
                    fracture. This study only began during the last half of
                    the year and involved a literature search and the
                    procurement of the testing equipment. To date it has
                    been shown that ingot segregation persisting from the
                    initial cast into the rolled plate creates small regions
                    in the plate that strain harden at a more rapid rate than
                    the rest of the material. These regions appear to have
                    very low ductility after prestraining and may be
                    responsible for the loss of toughness.

Thesis Directed: J. Mullican, "The Effect of Prestrain on the Fracture
                    Toughness of HY-Series Steel Plates," Master's Thesis,
                    April 1983.

Title: Elevated Temperature Fatigue of Alloys used in Propulsion
                    Systems

Investigator: Kenneth D. Challenger, Associate Professor of Mechanical
                    Engineering

Sponsor: NPS Foundation Research Program

Objective: To discover the damage mechanisms responsible for fatigue
                    failures at elevated temperatures.

Summary: The Central Electric Research Laboratories, Leatherhead,
                    England agreed to provide their vacuum fatigue testing
                    facilities for the fourth quarter of AY 81-82 to me for
                    this research. Thus, I spent three months in
                    England using their equipment for this research. The use
                    of vacuum testing was critical to conclusively
                    eliminating the effects of oxidation on fatigue at
                    elevated temperatures. It is now conclusively shown that
                    the major damage mechanism for steam generator alloys is
                    an interaction between oxidation and fatigue, not an
                    interaction between creep and fatigue as was believed to
                    be the case for many years. The elevated temperature
                    design community of the ASME must now revise their
                    methods of calculating fatigue damage for these alloys.

Publications: K. D. Challenger and P. G. Vining, "The Effects of Hold
                    Time in the Fatigue Crack Growth rate of $2^{1/4}$ Cr - 1Mo
                    Steel," ASME Journal of Engineering Materials and
                    Technology, forthcoming.

Title: Factors Affecting the Mechanical Properties of 5 Inch
                    Steel Cartridge Cases

Investigator: Kenneth D. Challenger, Associate Professor of Mechanical
                    Engineering

Sponsor: Naval Weapons Station

Objective: To determine the effect of various sample preparation
                    techniques used to determine the yield strength of these
                    cartridge cases on the measured mechanical properties of
                    the cases. The purpose for this study was to examine the
                    possibility of using yield strength as an acceptance
                    criteria instead of the presently used and very expensive
                    ballistic test.

Summary: Very useful information was determined from this study
                    that is leading toward an acceptable method for preparing
                    test specimens to measure the circumferential yield
                    stress of these cases. It has been shown that the best
                    method is to cut ring samples followed by slitting and
                    roller straightening. No stress relief is required and
                    infact, stress relieving is undesirable as it produces an
                    increase in yield strength due to strain aging. Thus,
                    the test specimens would have an artificially high yield
                    strength which might lead to accepting cases with actual
                    yield strengths below the specified minimum level.

Thesis Directed: F. Soyalp, "A Study of the Effect of Processing on the
                    Mechanical Properties of 5 Inch Cartridge Cases",
                    Master's Thesis, October 1982.

Title: Fracture Properties of HY-130 Weldments

Investigator: Kenneth D. Challenger, Associate Professor of Mechanical
                    Engineering

Sponsor: Naval Sea Systems Command/David W. Taylor Naval Ship
                    Research and Development Center

Objective: This was the second year of this research program. The
                    objective of this research is to develop an
                    understanding of the microstructure-fracture resistance
                    correlation for HY-130 weldments.

Summary: Careful studies of the weld metal, HAZ and base
                    metal microstructures have been completed using
                    transmission electron microscopy, TEM. This work in
                    conjuction with our study of hydrogen assisted cracking
                    (HAC) and HAZ fracture toughness has provided us with the
                    link between the weld parameter-microstructure fracture
                    correlation for this alloy. The low resistance to HAC of
                    the heat affected zone can be attributed to the presence
                    of twinned martensite which should not be present for
                    this alloy, but due to alloy segregation, it has occured
                    in a narrow region of the HAZ where the temperature
                    during welding has been just high enough to dissolve
                    carbides, but not high enough to allow the carbon to
                    diffuse away. Thus, when cooled, this region has a
                    higher carbon content than would be expected, leading to
                    the formation of twinned martensite. The low HAZ
                    toughness is due to the presence of coarse upper bainite
                    in the HAZ near the weld metal fusion line. These
                    results have confirmed the importance of the processing
                    of the metal before welding.

                    It is extremely important to have a homogeneous material
                    prior to welding if acceptable HAZ properties are to be
                    obtained.

Publications: K. D. Challenger and B. Mason, "Comparison of Hydrogen
                    Cracking Susceptibility of Cast and Rolled HY-130 Steel
                    Plate," accepted for presentation at the 64th annual
                    meeting of the American Welding Society, April 1983 and
                    submitted to the Welding Journal September 1982.

                    K. D. Challenger, R. B. Brucker, W. M. Elger and M. J.
                    Soreck, "Microstructure-Thermal History Correlations for
                    HY-130 Thick Section Weldments," also accepted for
                    presentation at the 64th AWS conference and submitted for
                    publication in Welding Journal.

Theses Directed: W. Elger, "Characterization of HY-130 Weld Heat Affected
                    Zones by TEM," Master's Thesis, December 1981.

B. Mason," The Use of the Implant Test to Study Hydrogen
Induced Cracking in Cast and Wrought HY-130 Steel,"
Master's Thesis, December 1981.

G. Rojas Abreu, "TEM Study of the HAZ of Cast HY-130
Weldments," Master's Thesis, October 1982.

Title: Experimental Investigation of the Fluid Mechanics of
                    Bouyant Liquid Plumes

Investigator: William G. Culbreth, Assistant Professor of Mechanical
                    Engineering

Sponsor: NPS Foundation Research Program

Objective: To investigate the velocity distributions in and around
                    heated jets of water introduced into a flowing ambient
                    using a Laser Doppler Velocimeter. Mathematical models
                    of bouyant jets and plumes are to be verified or modified
                    and entrainment coefficients are to be determined.

Summary: A Laser Doppler Velocimeter has been purchased and
                    interfaced to a computer-based data acquisition system.
                    A transversing mechanism was installed to allow movement
                    of the LDV with respect to the test section. The fluid
                    circuit was constructed to generate the heated jet of
                    liquid at variable flow rates. Testing of the system has
                    taken place and turbulent velocities have been measured
                    and stored by the data acquisition system.

Title:	Flow Visualization and Velocity Measurements Through the Use of a Pulsed Nitrogen Laser
Investigator:	William G. Culbreth, Assistant Professor of Mechanical Engineering
Sponsor:	None
Objective:	To explore the use of an experimental technique to aide in flow visualization and to measure velocity profiles in liquids. The technique is based on the use of the ultraviolet light emitted from an inexpensive pulsed nitrogen laser to excite a photochromic dye dissolved in a liquid.
Summary:	Small lasers have been developed and tested. Photochromic dye dissolved in light oil allowed the use of the technique to explore the fluid dynamics of growing droplets of oil in a model direct-contact, liquid-liquid heat exchanger. Dark traces induced in the dissolved dye by the nitrogen laser were photographed as they moved due to the internal droplet hydrodynamics and velocities were computed from digitized traces. The measured velocities agreed well with those predicted from theory.
Thesis Directed:	A. F. Pellin III, "An Experimental Technique for the Study of Velocity Profiles in a Growing Droplet Using a Pulsed Nitrogen Laser," Master's Thesis, March 1982.

Title:	Investigation of Simplified Boundary Conditions for Flows Over Flexible Surfaces
Investigator:	Matthew D. Kelleher, Associate Professor of Mechanical Engineering
Sponsor:	Naval Research Laboratory
Objective:	To determine the utility and range of validity of linearized boundary conditions in numerical investigations of flow over wavy surfaces.

Summary:

An investigation is being conducted into the feasibility of using simplified, linearized boundary conditions to describe the flow over wavy walls. The shape of the wavy wall is specified by some periodic function $\eta(x,t)$, where x, is the streamwise coordinate and t, is the time. The boundary conditions to be imposed on the Navier-Stokes equations at the wall are that the velocity components must take on the velocity of the wall. If it is assumed that the wall motion in the x direction is negligible these can be written as:

$$y = \eta(x,t) \quad u = 0$$

$$v = \frac{\partial \eta}{\partial t}$$

If the velocity components are expanded in a Taylor series about $y = 0$, and only the linear terms are retained, a linearized version of the boundary conditions evaluated at $y = 0$, can be written as:

$$y = 0 \qquad u + \frac{\partial u}{\partial y} \eta = 0$$

$$v + \frac{\partial v}{\partial y} \eta = \frac{\partial \eta}{\partial t}$$

The fact that these boundary conditions are evaluated at $y = 0$, is a great simplification.

The objective of this work is to investigate the region of validity in terms of wave amplitude and wave length, of these simplified, linearized boundary conditions. To carry out this task a copy of the spectral code for the analysis of the flow over wavy walls, developed by Cambridge Hydrodynamics Inc., has been obtained. This code has been installed on the CYBER 170/175 Computer at Fleet Numerical Oceanographic Center, Monterey. This code is being modified to incorporate the simplified boundary conditions.

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Title: Condenser Heat Transfer Augmentation

Investigators: P. J. Marto, Professor and Chairman of Mechanical
                          Engineering, and R. H. Nunn, Professor of Mechanical
                          Engineering

Sponsor: David W. Taylor Naval Ship Research and Development
                          Center

Objective: To develop a comprehensive computer model for the
                          analysis of Naval condensers which use enhanced heat
                          transfer tubing.

Summary: A one - dimensional computer code was utilized to assess
                          the benefits of using various heat transfer enhancement
                          schemes. Based upon the results to date, it has been
                          shown that the use of enhanced tubes can lead to
                          considerable reductions in condenser volume and weight.
                          Several enhanced tubing geometries were chosen to be
                          tested in a small bundle apparatus to determine the
                          effect of condensate inundation upon steam-side
                          performance.

Publications: R. H. Nunn and P. J. Marto, "Performance Rating of
                          Enhanced Marine condensers", NPS Technical Report,
                          NPS69-82-005TR, August 1982, 62 pages.

                          P. J. Marto and R. H. Nunn, "A Critical Review of Heat
                          Transfer Enhancement Techniques for use in Marine
                          Condensers," NPS Technical Report, NPS69-82-006TR,
                          September 1982, 59 pages.

Conference   P. J. Marto and R. H. Nunn , "The Potential of Heat
Presentation: Transfer Enhancement in Surface Condensers,"
                          International Conference on Condensers: Theory and
                          Practice, Manchester, U.K., March 1983.

Thesis   P. J. Noftz, "Effects of Condensate Inundation and Vapor
Directed: Velocity on Heat Transfer in a Condenser Tube Bundle",
                          Master's Thesis, June 1982.

Title: Enhanced Condensation of Steam on Horizontal Tubes

Investigator: P. J. Marto, Professor and Chairman of Mechanical
                  Engineering

Sponsor: National Science Foundation

Objective: To experimentally determine the influence of various
                  enhancement techniques upon steam condensation heat
                  transfer coefficients on a single horizontal tube.

Summary: A single tube apparatus was designed and constructed to
                  reliably measure steam condensation heat transfer
                  coefficients. The apparatus was constructed of stainless
                  steel and glass to avoid contamination problems and to
                  facilitate cleaning. A thick-walled, smooth copper tube
                  was instrumented with six wall thermocouples to measure
                  outside and inside coefficients. Data will be taken at
                  various steam velocities and will be compared to later
                  data using finned tubes and dropwise-promoted tubes.

Thesis
Directed: R. L. Krohn, "An Experimental Apparatus to Study Enhanced
                  Condensation Heat Transfer of Steam on Horizontal Tubes",
                  Master's Thesis, June 1982.

Title: Nucleate Pool Boiling Characteristics of a GEWA-T Finned
                    Surface

Investigator: P. J. Marto, Professor and Chairman of Mechanical
                    Engineering

Sponsor: None

Objective: To experimentally ascertain the important heat transfer
                    mechanisms which occur during nucleate pool boiling from
                    a GEWA-T finned surface.

Summary: A series of measurements were made with a 50mm long,
                    22mm OD solid copper cylinder whose outer surface was
                    finned into a GEWA-T profile as manufactured by
                    Wieland-Werke, AG. The cylinder was bored out to
                    accommodate a cartridge heater, having a thick annular
                    wall in which eight copper-constantan thermocouples were
                    soldered. Data were taken with Freon-113 at atmospheric
                    pressure. Results show that this surface can enhance
                    nucleate pool boiling heat transfer coefficients by over
                    300 percent.

Publication: P. J. Marto and Lepere, V. J., "Pool Boiling Heat
                    Transfer From Enhanced Surfaces to Dielectric Fluids,"
                    Journal of Heat Transfer, Vol. 104, No. 2, May 1982, pp.
                    292-299.

Thesis Directed: B. G. Hermandez, Jr., "An Experimental Study of Nucleate
                    Pool Boiling Heat Transfer from a GEWA-T Finned Surface in
                    Freon-113," Master's Thesis, December 1982.
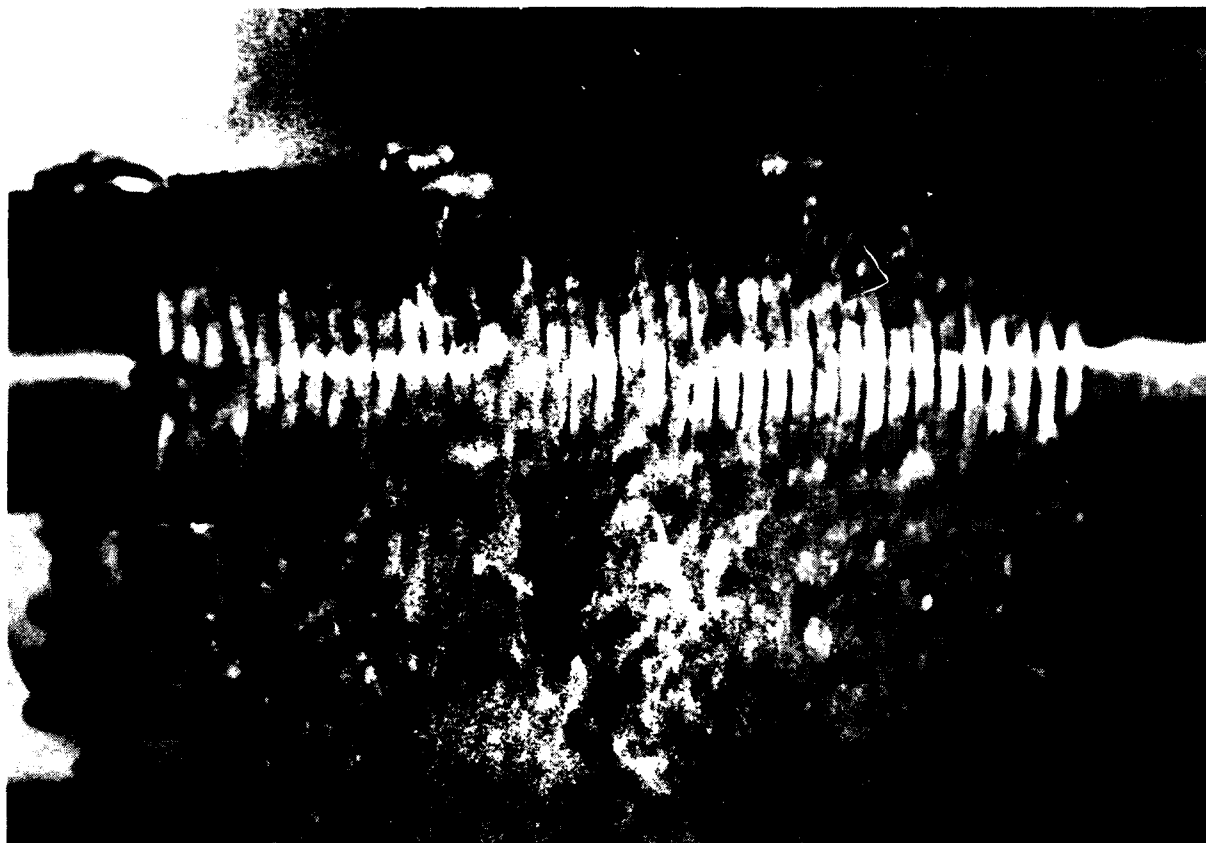
SIDE VIEW OF NUCLEATE BOILING FROM A GEWA-T FINNED SURFACE USED IN COM-
PACT EVAPORATORS.
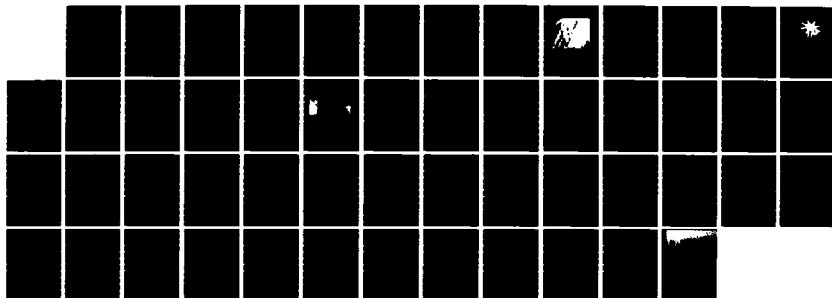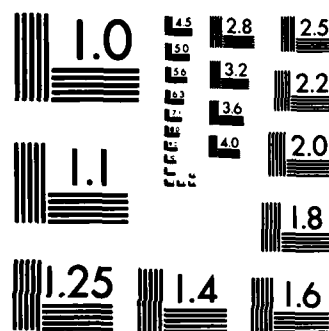
MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Title: Application of a Thermomechanical Process for Refinement
                    of Grain and Carbide Size in M-50 Steel

Investigator: T. R. McNelley, Associate Professor of Mechanical
                    Engineering, D. H. Boone, Adjunct Professor of
                    Mechanical Engineering, and A. Garg, Adjunct Research
                    Professor of Mechanical Engineering

Sponsor: Naval Air Propulsion Center

Objective: Investigation of Thermomechanical processing methods to
                    refine grain and carbide-size when applied to M-50
                    bearing steel and characterization of the influence of
                    such refinement upon the hardening characteristics and
                    mechanical properties of the steel.

Summary: The thermomechanical processing method essentially
                    consists of a heat treatment to dissolve carbides and
                    retain the carbon in solution; treatment is conducted at
                    relatively high temperatures to minimize the residual
                    carbide content. Subsequently the material will be
                    reheated, typically to about 700°C, and warm rolled with
                    frequent reheating. Deformations are large, typically 50%
                    to 90% reduction, and the final microstructure results
                    from recrystallization and interaction of
                    recrystallizing grains with fine temper carbides
                    developed by precipitation and controlled in size by the
                    rolling. To date, a supply of aircraft-bearing quality
                    M-50 steel has been acquired. Literature searches have
                    been conducted and attempts made to identify the key
                    differences between this steel and the 52100 steel or
                    previous studies. Preliminary heat treatments have been
                    conducted and microstructural studies undertaken to
                    identify the optimum initial heat treatment to apply
                    prior to warm rolling. Initial warm rolling trials are
                    currently in progress.

Thesis Directed: S. A. Barton, "A Study of the Effect of Interruped
                    Quenches on a Thermomechanically Processed High Carbon
                    Steel", Master's Thesis, September, 1982.

Title: High Strength Aluminum - Magnesium Alloys
Thermomechanical Processing, Microstructure and
Mechanical properties

Investigator: T. R. McNelley, Associate Professor of Mechanical
Engineering

Sponsor: Naval Air Systems Command

Objective: Continuation of research into the influence of processing
variables on the microstructure of thermomechanically
processed high-Magnesium Aluminum-Magnesuim alloys, with
special attention to transmission electron microscopy
study of microstructure. Effort will also be given to
examination of the influence of these processing
variables on tensile and fatigue characteristics of these
alloys.

Summary: During the past year, this effort has continued with the
primary emphasis on the relationship between
microstructrure and fatigue in these high Mg, Al-Mg
alloys. Several advances were made in the understanding
of microstructures by use of transmission electron
microscopy (TEM). The microstructures of these alloys
have been confirmed generally to consist of dislocation
sub-structures stabilized by precipitates formed during
warm rolling. Also, the importance of alloy additions
such as Cu and Mn in refining and homogenizing the
microstructure has been confirmed. The importance of
microstructural homogeneity in these alloys has been
demonstrated by showing the effect of increased solution
treatment times, from 10 hours to 24 hours, prior to warm
rolling to be improved microstructural homogeneity and a
concommitant 75% increase in fatigue strength for an
Al-8% Mg-0.4% Cu alloy. The TEM work in particular has
proven time consuming; however, the basis has been
established for more extensive work in this area.

Thesis Directed: R. H. Shirah, "The Influence of Solution
Treatment Time and Quench Rate on Microstructure and
Mechanical Properties of High Magnesium Aluminum
Magnesium Alloys", Master's Thesis, December 1981.

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Title: Liquid Crystal Thermography in Jet-Crossflow Interactions

Investigator: R. H. Nunn, Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: Investigate the feasibility of the use of liquid crystals
                    for mapping the surface interaction field that results
                    when a jet is injected into a crossing flow.

Summary: An experimental system was designed and built. Prelimi-
                    nary tests were conducted in which a number of design
                    improvements were suggested. In general, it was shown
                    that liquid crystal thermography can be a unique and
                    useful method for the qualitative analysis of complex
                    flow fields.

Thesis Directed: M. D. Johnson, "Liquid Crystal Mapping of Jet-Crossflow
                    Interactions," Master's Thesis, December 1981.

Title: Corrosion of Contemporary Naval Materials

Investigator: J. Perkins, Associate Professor of Mechanical
                 Engineering

Sponsor: Naval Sea Systems Command

Objective: To establish experimental work in a number of areas
                 pertinent to current naval structural materials, with
                 an aim to expand the data base and increase understand-
                 ing of the behavior of those materials in service
                 conditions.

Summary: The behavior of thermal-spray protective coatings has
                 been investigated in the first phase of this program.
                 Aluminum, zinc, and aluminum-zinc alloys have been
                 evaluated by a variety of laboratory techniques.

Title: Evaluation of High Damping Materials for Naval Ships
                    Applications

Investigators: J. Perkins and Y. Shin, Associate Professors of
                    Mechanical Engineering

Sponsor: Naval Sea Systems Command

Objective: To identify suitable materials for various high damping
                    applications in naval vessels, and to explore new
                    methods for their evaluation for such applications.

Summary: A survey of materials and methods has been completed.
                    A new test procedure including model analysis and the
                    required computer program is now being developed.
                    Actual testing and verification of the procedure is
                    being conducted on the HP-5451C Fourier Analysis
                    System under the direction of Professor Shin. Power
                    spectral density or mechanical impedance measuring
                    methods are considered to be adequate for the evalua-
                    tion of the damping capacity.

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Title: Martensitic Transformation in Shape Memory Alloys

Investigator: Jeff Perkins, Associate Professor of Mechanical
                  Engineering

Sponsor: NPS Foundation Research Program and National
                  Science Foundation

Objective: The general objective of the research is to examine
                  the effect of microstructural parameters on martensitic
                  transformation in shape memory alloys.

Summary: Considerable progress has been made in the examination
                  of the effects of microstructural variables, including
                  grain size and dislocation substructure. Effects of
                  transformation kinetics have also been studied in
                  detail.

Publications: Jeff Perkins, "Ti-Ni and Ti-Ni-X Shape Memory Alloys,"
                  Metals Forum, the Journal of the Australasian Institute
                  of Metals, 4(1981), 153-163.

                  Jeff Perkins, "Shape Memory Behavior and Thermoelastic
                  Martensitic Transformations," Materials Science and
                  Engineering, 51(1981), 181-192.

                  Jeff Perkins, "Rapid Solidification Effects in
                  Martensitic Cu-Zn-Al Alloys," Metallurgical
                  Transactions 13A(1982), 1367-1372.

                  Jeff Perkins and W. E. Muesing, "Martensitic
                  Transformation Cycling Effects in Cu-Zn-Al Shape
                  Memory Alloys," Metallurgical Transactions, forthcoming.

                  Jeff Perkins, "The Microstructure of Rapidly Solidified
                  β-Phase Cu-Zn-Al Alloys," submitted to Metallurgical
                  Transactions.

                  Jeff Perkins, "Effects of Austenite Microstructure on
                  Martensitic Transformations in Cu-Zn-Al Shape Memory
                  'Training' in Cu-An-Al Alloys," submitted to
                  Metallurgical Transactions.

Conference   Jeff Perkins, "Effects of Austenite Microstructure on
Presentations: Martensitic Transformations in Cu-Zn-Al Shape Memory
                  Alloys," International Conference on Martensite
                  Transformations, Leuven, Belgium, August 1982.

                  Jeff Perkins, "Transformation Cycling Effects in
                  Martensitic Cu-Zn-Al Shape Memory Alloys," Fall 1982
                  Meeting of the Metallurgical Society, St. Louis, MO,
                  October 1982.

Theses Directed: William E. Muesing, "Thermal Martensitic Transformation Cycling in Cu-Zn-Al Shape Memory Alloys," *Master's Thesis*, March 1982.

Richard O. Sponholz, "An Investigation into the Two-Way Shape Memory Trainability of Polycrystalline Cu-Zn-Al Alloys," *Master's Thesis*, June 1982.

DISLOCATION ARRAYS, WHICH ARE LEFT BEHIND IN THE PARENT PHASE BY REVERTED MARTENSITE PLATES, HAVE BEEN RELATED TO THE THERMOMECHANICAL PERFORMANCE OF CuZuAl SHAPE MEMORY ALLOYS. TEM IMAGE. IMAGE WIDTH ABOUT 1.5×10^6m.

Title: Ejector-Diffuser Improvement Program

Investigator: P. F. Pucci, Professor of Mechanical Engineering

Sponsor: Naval Air Propulsion Center

Objective: Design, fabricate and test models of existing and
                    proposed eductor-diffuser systems for aircraft gas
                    turbine engine altitude test cells.

Summary: Project began in June, 1982. The design and fabrication
                    of a cold flow facility was initiated. Concurrently,
                    fabrication of models of existing systems at NAPC was
                    begun. Work will continue into FY83.

Thesis Directed: J. Molloy, "Ejector-Diffuser Improvement Program,"
                    Master's Thesis, June 1983.

Title: Fluidized Bed Heat Exchanger

Investigator: P. F. Pucci, Professor of Mechanical Engineering

Sponsor: None

Objective: Design, fabricate and test a fluidized bed heat exchanger
                    employing a rectangular crossection bed with two opposite
                    wall heaters.

Summary: Project began in July 80. After extensive literature
                    survey, the rectangular cross section bed was selected.
                    The effect of geometry on fluidization and heat transfer
                    was begun.

Title: Gas Turbine Engine Exhaust Stack Eductor Systems

Investigator: P. F. Pucci, Professor of Mechanical Engineering

Sponsor: None

Objective: Design, fabricate and test models of gas turbine engine
                    exhaust stack eductor systems for naval ships. Both cold
                    and hot flow tests were made.

Summary: Project was initiated by NAVSEA in FY76 and funded
                    through FY81. Many eductor system concepts have been
                    tested and reported on during this period. During FY82 a
                    shrouded, short mixing stack with angled nozzles was
                    tested in both cold flow and hot flow facilities, and
                    will continue into FY83.

Theses Directed: C. Drucker, "Characteristics of a Four-Nozzle, Slotted
                    Short Mixing Stack with Shroud, Gas Eductor System,"
                    Master's Thesis, March, 1982.

                    I. Eick, "Testing of a Shrouded, Short Mixing Stack
                    Gas Eductor Model Using High Temperature Primary Flow,"
                    Master's Thesis, June, 1982.

VIEW OF SINGLE FLUTED NOZZLE FABRICATED AND TESTED FOR USE ON A MODEL GAS TURBINE ENGINE EXHAUST STACK EDUCTOR SYSTEM FOR NAVAL SHIPS. THIS IS PART OF AN ONGOING RESEARCH PROJECT TO ECONOMICALLY REDUCE GAS TURBINE EXHAUST GAS TEMPERATURES.

Title:	Advanced Composites Fire Response Program
Investigator:	D. Salinas, Associate Professor of Mechanical Engineering
Sponsor:	Naval Weapons Center
Objectives:	Development of a mathematical model to predict the thermal behavior of a composite structure in a fire environment.

Development of a mathematical model to predict the strength of a composite structure in a fire environment. |
Summary:	Mathematical models for the determination of the thermal and strength behavior of composites in a fire environment were developed. Computer programs for both models have been implemented. A series of computer analyses have been executed and the results have provided fundamental understanding of the effects of environment and design on system behavior. The programs have been modified to account for a larger class of problems, and grapics have been incorporated into the programs in order to assimilate the analysis output. The results of the analyses have been reported to the sponsor.
Publication:	D. Salinas, "Advanced Composites Fire Response Program: Progress Report," NPS Technical Report NPS-69-82-007, September, 1982.
Thesis Directed:	C. S. Vatikiotis, "A Combustion and Heat Transfer Model for Porous Media", Ph.D. Thesis, June 1982.

Title: FEM Analysis of an Internally Finned Rotating Heat Pipe

Investigators: D. Salinas, Associate Professor of Mechanical
                    Engineering, and P. J. Marto, Professor and Chairman of
                    the Department of Mechanical Engineering

Sponsor: None

Objective: Development of an analytical model for the determination
                    of the behavior of internally finned rotating heat
                    pipes.

Summary: A mathematical model of a finned rotating heat pipe has
                    resulted in a computer program. A series of computer
                    analyses shows the effects of design parameters, such as
                    coolant, fin material, fin geometry, and rotational RPM,
                    on heat transfer.

Title: Hydroelastic Oscillation of Cylinders in Harmonic
                        Flow

Investigator: Turgut Sarpkaya, Distinguished Professor of Mechanical
                        Engineering

Sponsor: National Science Foundation

Objective: Understanding of the fluid-mechanical phenomena
                        leading to hydroelastic oscillations and the deter-
                        mination of the paramaters controlling the oscilla-
                        tions.

Summary: The research program has continued on several fronts.
                        Experiments have been performed with smooth and rough
                        cylinders immersed in harmonically oscillating flow
                        in a large U-shaped water tunnel. The results have
                        been analysed in terms of the governing parameters to
                        determine the characteristics of synchronized oscilla-
                        tions. A numerical model based on the discrete vortex
                        analysis has been developed and applied to steady and
                        unsteady flows about cylinders. The model took into
                        consideration the time-dependent boundary layer, redis-
                        cretization of shear layers, and circulation dissipa-
                        tion. The predictions of the model compared extremely
                        well with those obtained experimentally.

                        A number of publications and theses have been generated
                        since the project's inception; only those for FY '82
                        are listed.

Thesis
Directed: Dean O. Trytten, "Wave Forces on Inclined Smooth and
                        Rough Circular Cylinders," Master's Thesis, March 1982.

Title: Impulsively-Started Flow About Submarine-Shaped Bodies

Investigator: Turgut Sarpkaya, Distinguished Professor of Mechanical
                       Engineering

Sponsor: David W. Taylor Naval Ship Research and Development
                       Center

Objective: To perform experimental investigations in support of
                       DTNSRDC's analytical modeling of separated flow past
                       submarine-shaped bodies of special interest to naval
                       hydrodynamics.

Summary: The research efforts have been designed to experimen-
                       tally determine the force coefficients acting on two-
                       dimensional bodies in impulsively-started flows. In-
                       vestigators have included within the limitations of
                       the experimental facility, force coefficients versus
                       time for a variety of flow/body orientations (e.g.,
                       angle of attack) and Reynolds number. Experiments
                       have been carried out in a vertical water tunnel with
                       a D-shaped cylinder. Additional experiments will be
                       performed during the coming year.

                       A number of publications and theses have been generated
                       since the project's inception; only those for FY 82
                       are listed.

Publication: T. Sarpkaya and H. K. Kline, "Impulsively-Started
                       Flow About Four Types of Bluff Body," Journal of
                       Fluids Engineering of ASME, Vol. 104, June 1982,
                       pp: 207-213.

Title:	Internal Waves in Stratified Fluids
Investigator:	T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor:	Defense Advanced Research Projects Agency
Objective:	To perform analysis and experiments to determine the characteristics of the internal waves generated by the motion of underwater bodies.

Summary: A large water channel has been constructed and equipped with filling and emptying facilities and a towing carriage. The channel may be stratified at any desired stratification gradient.

Experiments have been carried out with Delta-wing bodies at various angles of attack and forward speed. The characteristics of vortices and the internal waves have been evaluated. The work is continuing.

Publication: T. Sarpkaya and S. K. Johnson, "Trailing Vortices in Stratified Fluids," NPS Technical Report, NPS-69-82-003, June 1982.

Conference
Presentation: T. Sarpkaya, "Motion of Trailing Vortices in a Stratified Fluid," National Congress of Theoretical and Applied Mechanics, Ithaca, N.Y., June 1982.

Theses
Directed: Christos Striftos, "Motion of Submerged Bodies in Stratified Fluids," Master's Thesis, December 1982.

Steven K. Johnson, "Trailing Vortices in Stratified Fluids," Engineer's Thesis, June 1982.
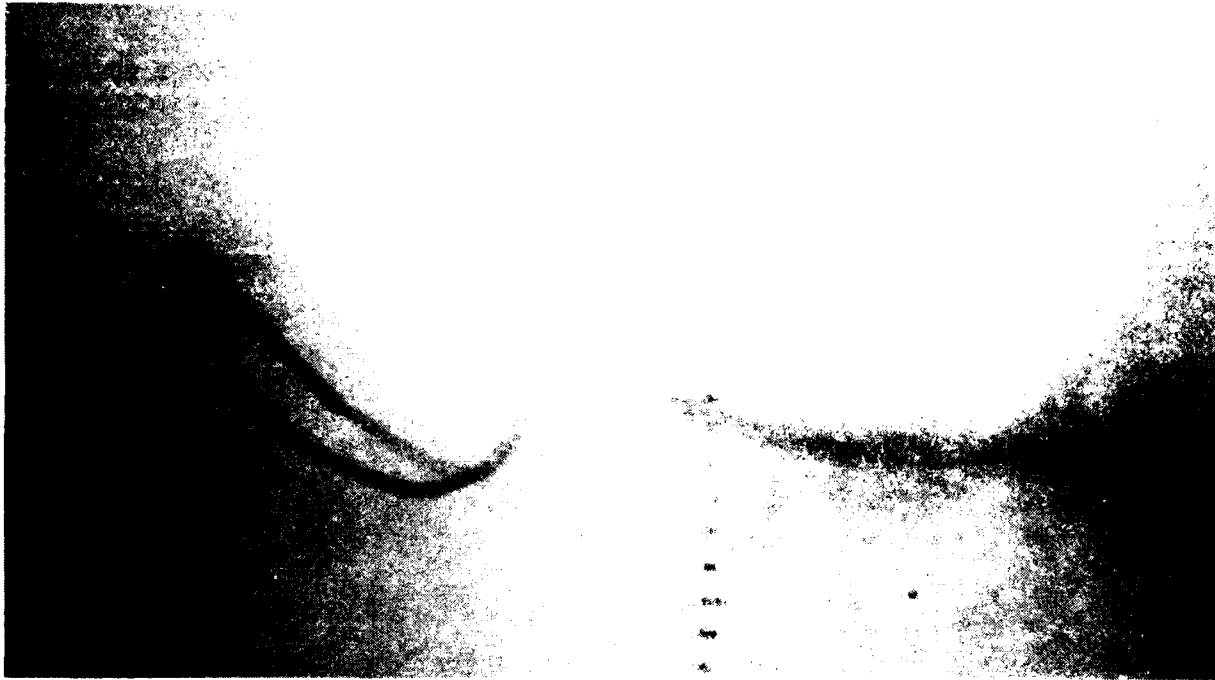
EVOLUTION OF THE AIRCRAFT TRAILING VORTICES

TRAILING VORTICES BEGIN AS HORSESHOE VORTICES, AS IN THE PICTURE ABOVE, THEN FORM TWO PARALLEL LINE VORTICES. THESE VORTICES ARE DESTROYED SUBSEQUENTLY, EITHER DUE TO VORTEX BREAKDOWN OR SINUSOIDAL INSTABIL-ITY. THE EFFECT OF LAMINAR AND TURBULENT DIFFUSION IS EVER PRESENT IN THESE PROCESSES.

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Title: Low Airspeed Sensors

Investigator: Turgut Sarpkaya, Distinguished Professor of
                          Mechanical Engineering

Sponsor: Naval Air Systems Command

Objective: To investigate air data measurement requirements
                          for helicopters and V/STOL aircraft. Included
                          in the research are the factors of omnidirectional
                          low airspeed measurement, wind and gust data
                          at remote and unprepared sites, rapid and
                          accurate determination of the sink rate in
                          vertical-mode operation, and the measurement
                          of flow angle at low airspeed.

Summary: The characteristics of the existing low airspeed
                          sensors have been critically assessed in terms
                          of their accuracy, range, reliability, sensiti-
                          vity to environmental conditions, electronics,
                          and price. This has led to the recommendation
                          that new concepts and devices are needed to
                          meet the airdata needs of the current and future
                          naval aircraft.

                          A speed sensor based on jet-interaction principle
                          has been designed and is currently being tested.

                          A number of publications and theses have been
                          generated since the project's inception and
                          were listed in prior research reports.

Title:	Reliability-based Analysis of Random High Cycle Fatigue Life
Investigator:	Y. S. Shin, Associate Professor of Mechanical Engineering
Sponsor:	NPS Foundation Research Program
Objective:	To develop the reliability-based analysis method of high-cycle fatigue life under the random vibration enviroments, and to develop a related computer program to evaluate the fatigue life as a probability of survival.
Summary:	An extensive literature search for high-cycle fatigue test data was completed and statistical variability of the fatigue damage index at failure was evaluated. As a result, a Weibull distribution function was found to be a best probability model for the critical fatigue damage index. The analytical equations were formulated. A computer program, "FATIGUE", was developed and is operational on NPS-IBM computer. Parametric studies were performed to evaluate the sensitive parameters to fatigue life. The need to develop a fatigue life prediction for the multi-axial state of stress was identified and the efforts have been made to look into the details of fatigue failure criterion.
Publication:	Y. S. Shin, "Reliability-based Analysis of Random High-Cycle Fatigue Life," NPS Technical Report, in Progress.
Conference Presentations:	Y. S. Shin, "Reliability-based Fatigue Damage Predictions Under Random Vibration Environment," submitted for presentation at the AIAA/ASME/ASCE/AHS 24th Structures, Structural Dynamics, and Materials Conference in Lake Tahoe, Nevada on May 2-4, 1983
	Y. S. Shin, and R. W. Lufkins, "Probability Based High-Cycle Fatigue Life Predictions.," Accepted for the presentation at the ASME 4th National Congress on Pressure Vessel and Piping Conference in Portland, Oregon on June 19-24, 1983.
Thesis Directed:	R. W. Lufkins, "A High-Cycle Fatigue Life Predictions under the Multiaxial State of Stresses.", Master's Thesis, (To be reported on June, 1983)

Title: Development of a Library of Numerical Optimization
                      Programs for Engineering Design

Investigator: Garret N. Vanderplaats, Associate Professor of Mechanical
                      Engineering

Sponsor: NASA Langley Research Center

Objective: To develop a library of FORTRAN programs for engineering
                      design optimization using state-of-the-art techniques.

Summary: The program structure has been established and
                      approximately 100 subroutines have been written and
                      incorporated into the program.

                      A preliminary version of the program, called "ADS-1" will
                      be delivered in March of 1983. This program will have
                      between 50 and 100 different combinations of algorithms
                      available for optimization.

Thesis Directed: James Fitzgerald, III, "Development of a Computer Program
                      for Testing and Evaluation of Numerical Optimization
                      Techniques," Master's Thesis, June 1982.

Title:	Optimum Design of Torsional Shafts Using Composite Materials
Investigator:	Garret N. Vanderplaats, Associate Professor of Mechanical Engineering
Sponsor:	NPS Foundation Research Program
Objective:	To develop the analytic capability and FORTRAN program for the analysis of shafts made of multi-layered composite materials and couple this to a numerical optimization program to provide a general automated design capability.
Summary:	The program has been developed and demonstrated with the design of isotropic and composite shafts. Two theses have been written as part of this research and a third has directly used the results of this research.
Theses Directed:	Virgilio S. Merced, "Drive Shaft Design Using Numerical Optimization, "Master's Thesis, June 1980.
	Amhed Onal, "Design of Composite Driveshafts using Nummerical Optimization," Master's Thesis, December 1981.
	James Hopper, "Probabilistic Design Using Numerical Optimization, "Master's Thesis, October 1982.

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